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VA DEPARTMENT OF ENVIRONMENTAL QUALITY
NORTHERN
APR 03 2014
REGIONAL OFFICE
WOODBRIDGE, VA

March 27, 2014

Thomas A. Faha
Department of Environmental Quality
Northern Regional Office
13901 Crown Court
Woodbridge, VA 22193

Dear Mr. Faha:

Enclosed for your review is the Annual Report for Lake Anna, Waste Heat Treatment Facility, and the Lower North Anna River for 2013. The data indicate that Lake Anna and the Lower North Anna River continue to support a well-balanced ecological community and both remain some of the finest recreational resources in Virginia.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Please let me know if you have any questions concerning this information as well as any other ongoing environmental monitoring for North Anna Power Station.

Sincerely,

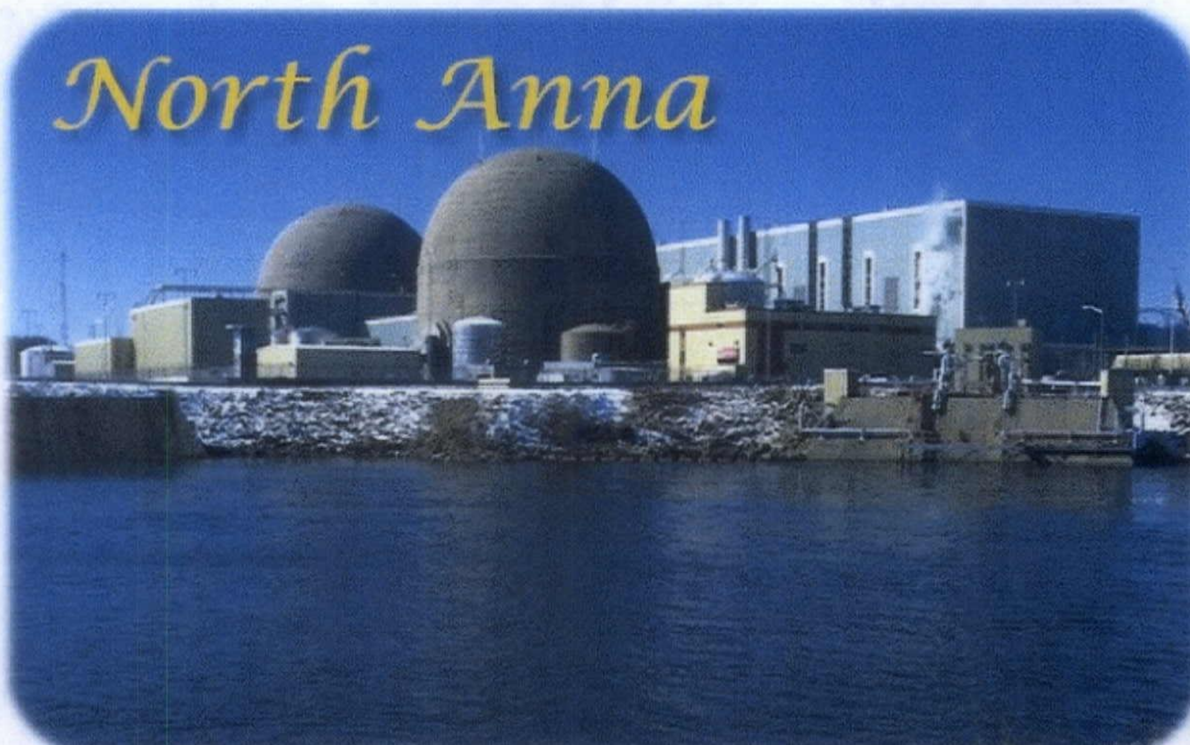
Cathy C. Taylor

Cathy C. Taylor
Director – Electric Environmental Services

cc: w/enclosure
Mr. John Odenkirk
Virginia Department of Game and Inland Fisheries
1320 Belman Road
Fredericksburg, VA 22401

ENVIRONMENTAL STUDY OF LAKE ANNA, WASTE HEAT TREATMENT FACILITY AND THE LOWER NORTH ANNA RIVER

ANNUAL REPORT FOR 2013



Prepared by:

ENVIRONMENTAL BIOLOGY

ELECTRIC ENVIRONMENTAL SERVICES

TABLE OF CONTENTS

Executive Summary

This report presents the findings of various ecological studies conducted by Dominion biologists in 2013 on Lake Anna (lake), the Waste Heat Treatment Facility (WHTF) and the North Anna River downstream of the dam. The studies were conducted in accordance with the 2008 study plan that was approved by the Department of Environmental Quality (DEQ) and the Virginia Department of Game and Inland Fisheries (DGIF). The 2013 studies were performed to address the requirements of the NPDES permit for North Anna Power Station and continue to support the 316 (a) demonstration for the station that the operation of the power station has not resulted in appreciable harm to the biological community.

North Anna Power Station operated at an average of 90% for Unit 1 and 86.5% for Unit 2 of net megawatt generation capacity in 2013. Unit 1 was shut down for approximately 32 days from September 8 through October 10, and for approximately 51 hours October 11 through October 13. Unit 2 was shut down for approximately 32 days from April 7 through May 9, for approximately 11 days from May 10 through May 22 and for approximately 2 days from May 28 through 30.

The maximum hourly water temperature recorded in 2013 was 38.9°C in July at station NADISC1, located in the WHTF and the minimum was 3.6°C in January at station NAL719NT, located in the lake. The maximum and minimum hourly temperatures recorded in the WHTF and lake are within the range of previously reported (years; 1981-2012) maximum and minimum temperatures. In addition to hourly temperature monitoring, standard physicochemical measurements (water temperature, dissolved oxygen, pH, and conductivity) were recorded at the time of biological sampling and were within the values to support a healthy fishery.

In the quarterly lake gill net samples, White Perch, Channel Catfish and Black Crappie had a catch per unit effort (CPUE) that was significantly higher than the 1981-2012 average. Striped bass CPUE for 2013 was higher than the historical average but the difference was not significant. Gizzard Shad CPUE was significantly lower than the 1981-2012 average.

In the quarterly WHTF gill net samples, Gizzard Shad, White Perch, Striped Bass and Common Carp had a CPUE that was significantly higher than the historical average. Channel Catfish had a CPUE that was significantly lower than the historical average. Channel Catfish, Striped Bass, White Perch, Black Crappie, Common Carp and Gizzard Shad have commonly ranked high in the gillnet catches in the lake and WHTF.

Centrarchids (sunfishes) continue to be the numerically dominant fish taxa collected by quarterly electrofishing surveys in Lake Anna and WHTF in 2013. Largemouth Bass and Threadfin Shad had a 2013 CPUE that was significantly higher than the 1981-2012 average. The differences among Bluegill, Green Sunfish, Redear Sunfish and their historical averages were not significant. In the WHTF, Channel Catfish had a CPUE that was significantly higher than the 1981-2012 average and Bluegill, Largemouth Bass, Green Sunfish and Redear Sunfish had catch rates that were significantly lower than the historical average.

Data collected during the biannual surveys for Asiatic clams reveal highly variable catches from year to year with decreasing average catch at the WHTF-1 and Intake stations. Size distributions of clams indicate that high catches of clams are driven by spring spawning events but the majority of those young clams do not move into the older year classes, therefore reducing the risk of biofouling at North Anna.

As for the North Anna River (NAR) below the dam, continuous temperature data at station NARIV601 was not captured during the months of July and August, and limited data was captured for June (n=106) and September (n=464) due to an error in the data logger setup. The maximum recorded temperature in 2013 was 30.2˚C in September. Historically, the maximum water temperature has occurred in July or August.

NAR electrofishing surveys occur three times a year, once per month in May (survey 1), July (survey 2) and September (survey 3) and utilize electric seine and backpack electrofishing. The CPUE for the electric seine on surveys 1, 2 and 3 in 2013 were 468.5, 257.8, and 200.0 respectively. CPUE for all electric seine surveys in 2013 were significantly higher than the historical means. The CPUE for the backpack on surveys 1, 2 and 3 in 2013 were 32.5, and 30.4 and 35.2 respectively. CPUE for all backpack surveys in 2013 were significantly lower than the historical means.

Electrofishing CPUE in the North Anna River is highly variable. Although 2013 electrofishing CPUE was higher on some surveys and lower on others; species richness has remained high in the North Anna River samples which are indicative of a diverse fish community.

Young of year (YOY) smallmouth bass sampling and otolith aging were conducted in 2013 to investigate smallmouth bass spawning, recruitment and to examine the influence of the North Anna River flow and water temperature on spawning duration. Smallmouth bass were primarily collected using a recently purchased Zodiac electrofisher comprised of a Mark II Zodiac boat outfitted with a Smith-Root Type VI-A control box, single boom umbrella array and a 5000W Honda generator. The boat was placed in service in October 2013 which is much later in the year than when previous sampling has been conducted, resulting in fewer YOY fish which were older and harder to age than previous years.

Six (6) YOY smallmouth bass were collected in 2013 and age data derived from them were compared to the dataset from 2008-2012. Eighty-eight percent (88%) of the YOY that were collected from 2008-2013 were spawned when river flows were less than or equal to 400 cfs. Although river flows differed among all four years, the majority of the spawning occurred when flows were maintained at a fairly consistent level at or below 400 cfs during the spawning season. This was not the case in 2009 when major fluctuations occurred in the river flows which resulted in YOY not being collected. The poor smallmouth bass spawning year in 2009 was not unique to the North Anna River. Poor smallmouth bass spawns were noted throughout the state of Virginia in 2008 and 2009 (DGIF 2011).

River water temperatures were used to assess the potential effects of water temperature on spawning success and spawning duration in the North Anna River. The accumulation of heating degree days (degree days) greater than 10°C was examined in relation to the beginning, duration, and the end of the Smallmouth Bass spawning seasons in 2008-2013 using a correlation analysis. The correlation analysis found that the higher the degree days at the start of the spawning season the shorter the spawning season will be. This relationship does not imply that degree days cause the shorter season, but only that spawning season duration decreases as the degree day value at the start of the season increases.

In addition to the YOY analysis, data for adult and juvenile Smallmouth Bass caught on the Zodiac electrofishing survey were analyzed. Thirty-four bass were caught from 5 pools at a rate of 24.3 fish per hour. When plotted the Smallmouth Bass lengths were normally distributed. Fifty percent (50%) of the bass fell into the 225-275mm and 275-325mm length classes with a combined catch rate of 12.1 fish per hour. YOY Smallmouth Bass fell into the 75-125mm size class and had a catch rate of 2.1 fish per hour.

Boat electrofishing surveys will be continued and are intended to provide annual catch rates to gage year class strength. As the dataset grows, we should begin to better understand what factors may be affecting the spawn and recruitment of smallmouth bass in the North Anna River.

Biological systems are highly complex and are influenced by many environmental factors. It is difficult to determine exact causes of changes seen in sampling results especially since there are so many natural shifts in reproduction, growth, survival and distributions of aquatic organisms. Overall, the 2013 data (species richness, water quality and relative abundance of fishes) indicate that the lake, WHTF and river downstream of the lake continue to support a diverse, healthy, and balanced fisheries community.

LIST OF FIGURES

LIST OF TABLES

Table Number	Title	Page

1.0 Introduction

In 1972, the North Anna River was impounded to create Lake Anna, a 3885 hectare (9600 acres) reservoir (lake) that provides condenser cooling water for the North Anna Power Station (NAPS). Adjacent to Lake Anna is a 1376 hectare (3400 acre) Waste Heat Treatment Facility (WHTF) that receives the cooling water and transfers excess heat from the water to the atmosphere before discharging into the lake.

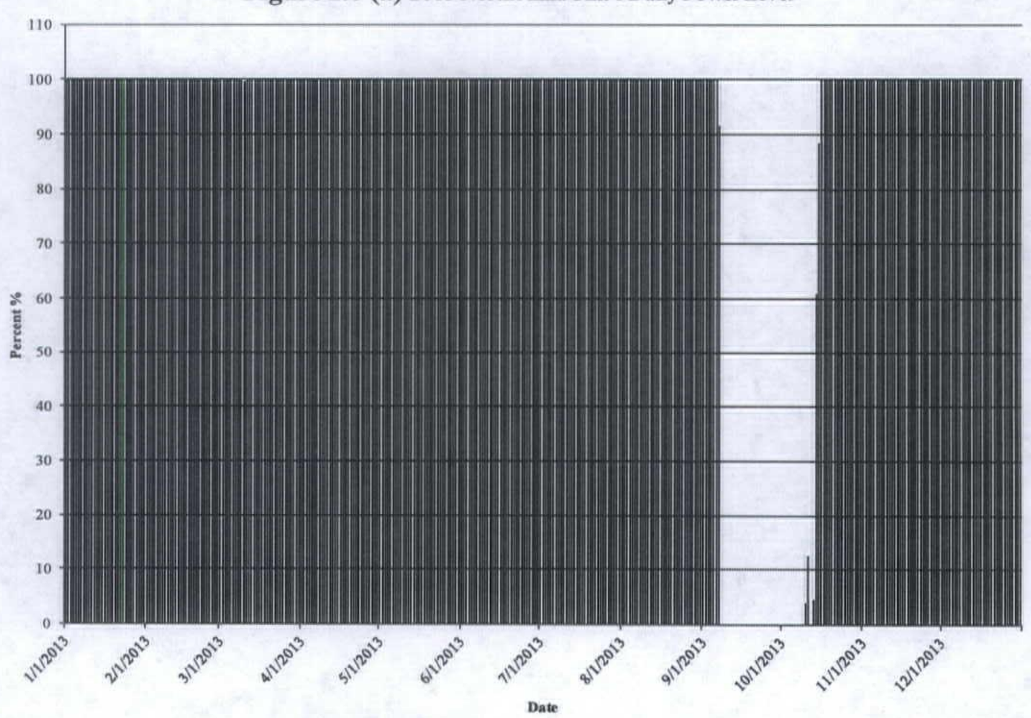
Aquatic monitoring studies have been conducted on Lake Anna, the WHTF and the North Anna River below the dam since their inception. In January, 1984, the Company initiated an extensive Section 316(a) demonstration study (P.L. 95-500) to determine if proposed effluent limitations on thermal discharges from the power station were more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in Lake Anna and the lower North Anna River. The final report (Virginia Power 316(a) Report 1986) successfully demonstrated that the operation of the power station had not resulted in appreciable harm to the biological community. The Virginia Water Control Board (VWCB) accepted the study as a successful demonstration in September, 1986.

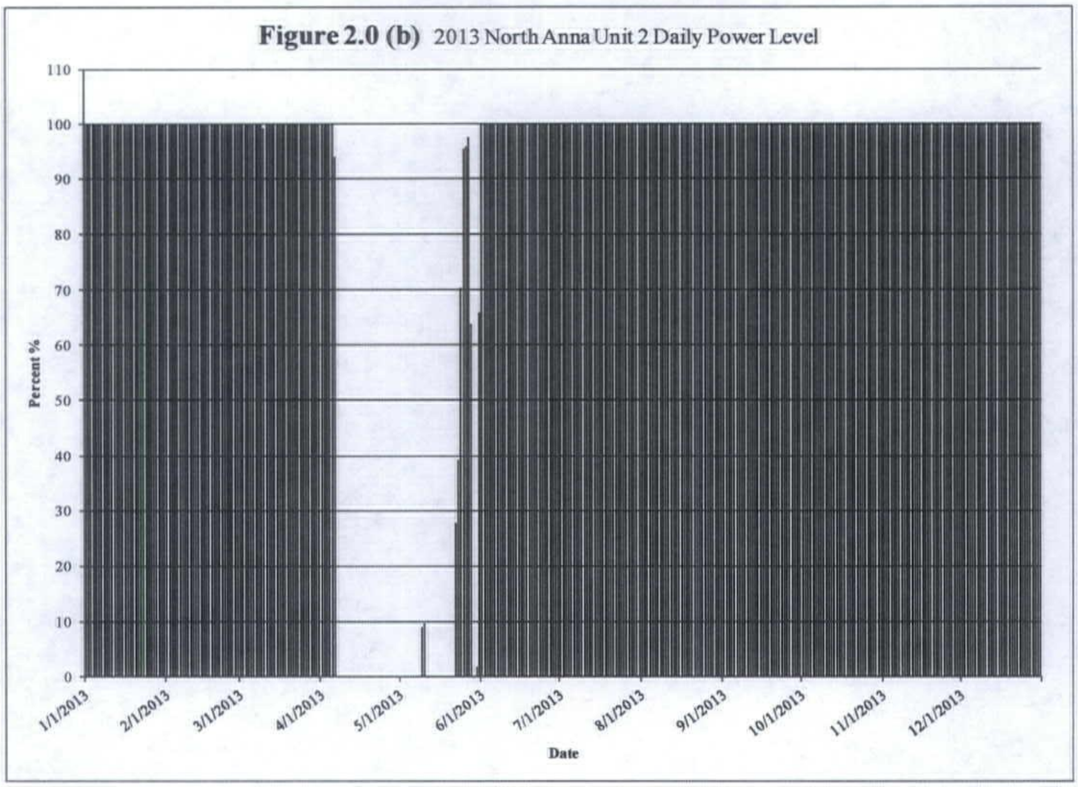
Subsequent to the 316(a) study, the Company committed to continue selected environmental studies on Lake Anna, WHTF and the lower North Anna River as part of a post-316(a) agreement. A new VPDES permit for NAPS (permit VA0052451) was issued in October of 2007. In accordance with, "Section E, item 13 i.e., Post 316(a) monitoring", a Department of Environmental Quality (DEQ) approved monitoring plan was created and implemented in 2008 which is based on historical studies with the addition of a smallmouth bass population study and an initial freshwater mussel search. A report summarizing data from each year is prepared and submitted to the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Game and Inland Fisheries (DGIF). This report presents the findings for calendar year 2013.

2.0 Station Operation

North Anna Power Station operated at a factor of 90.0% for Unit 1 and 86.5% for Unit 2 of net megawatt generation capacity in 2013. Unit 1 was shut down for approximately 32 days from September 8 through October 10, and for approximately 51 hours October 11 through October 13. Unit 2 was shut down for approximately 32 days from April 7 through May 9, for approximately 11 days from May 10 through May 22 and for approximately 2 days from May 28 through May 30 (Figures 2.0a and 2.0b).

Figure 2.0 (a) 2013 North Anna Unit 1 Daily Power Level





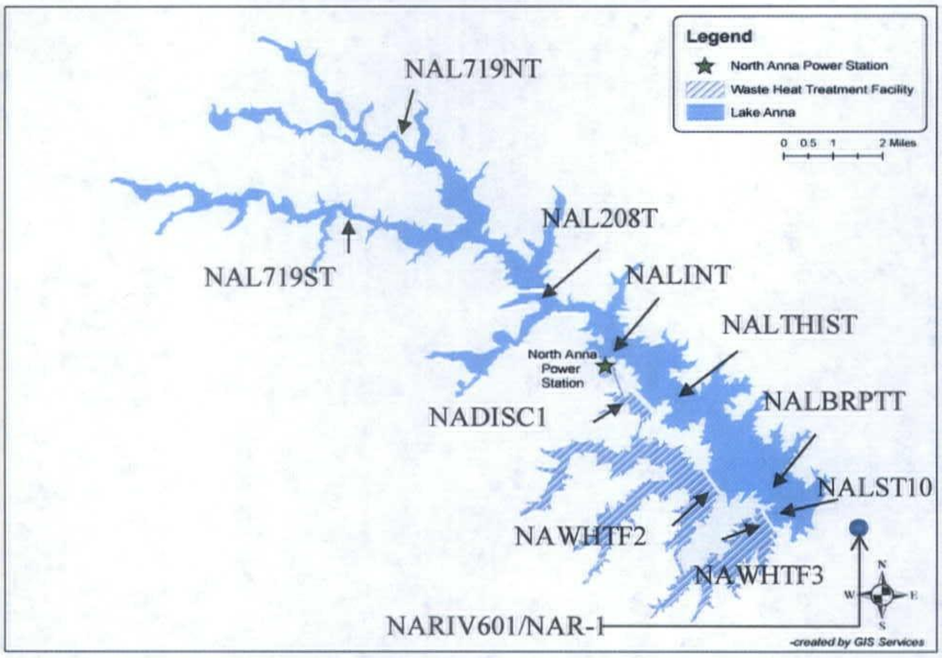
3.0 Lake Anna

3.1 Temperature

Methods

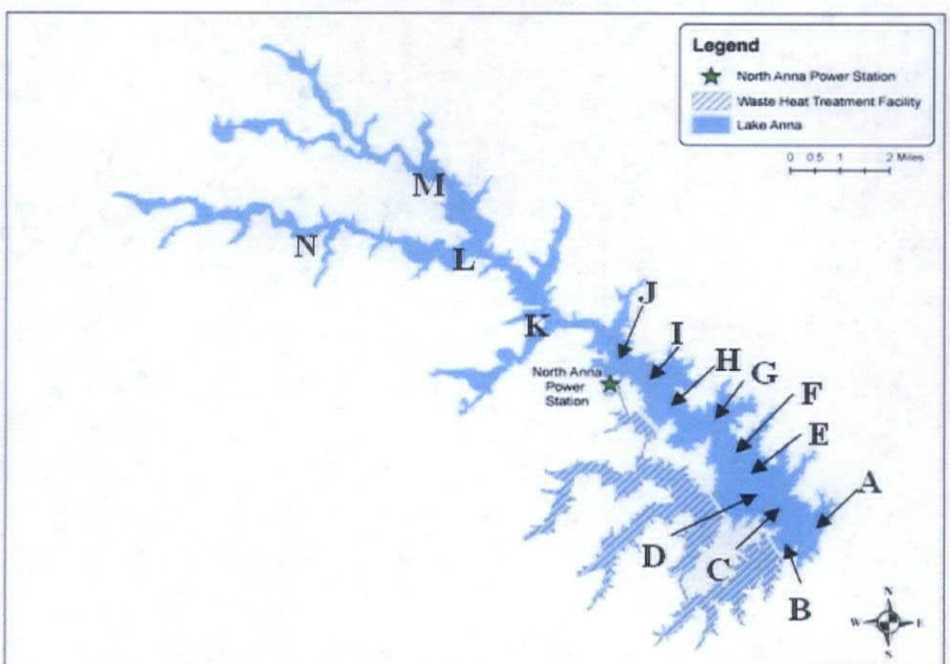
Lake, WHTF, and North Anna River water temperature data were collected using continuous monitors (fixed temperature recorders) and instantaneous temperature field surveys. Continuous temperature was measured with Solinst Levelogger (±0.1°C) temperature recorders which measured and recorded the water temperature at one hour intervals. Temperature recorders were placed at a depth of one meter at seven stations in the lake, three stations in the WHTF and one station in the river (Figure 3.1-1). The instrument at NALST10 was located at a depth of three meters to account for the turbulence associated with water discharges from the WHTF to the lake.

Figure 3.1-1 Approximate location of temperature recorders in Lake Anna, WHTF and the North Anna River



Instantaneous temperature was measured using a Hydrolab MS5 data sonde (± 0.1°C). Instantaneous temperature was measured at one meter intervals, from the surface to the bottom, at each of 14 stations in Lake Anna (Figure 3.1-2).

Figure 3.1-2 Approximate location of thermal plume sampling stations on Lake Anna



Results and Discussion

The maximum hourly temperature recorded in the WHTF in 2013 by continuous monitors was 38.9°C in July at station NADISC1 which is located at the end of the discharge canal (Table 3.1-1). The minimum hourly temperature recorded in the WHTF in 2013 was 10.9°C in January at Station NAWHTF3 which is located near the dike in the third lagoon. The maximum and minimum temperatures in the WHTF for 2013 are in the range of previously reported maximum and minimum temperatures for the WHTF.

The maximum hourly temperature recorded in the lake in 2013 by continuous temperature monitors was 33.0°C in July at station NAL719ST. The minimum hourly temperature recorded in the lake in 2013 was 3.6°C in January at NAL719NT. Due to an error in the data logger setup, continuous temperature data at station NARIV601 were not captured during the months of July and August, and limited data were captured for June (n=106) and September (n=464). Temperatures recorded in the lake, WHTF and river were within the range of previously reported maximum and minimum lake temperatures.

TABLE 3.1-1 SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 2013. ALL RESULTS ARE CALCULATED FROM HOURLY TEMPERATURES (IN DEGREES CELCIUS). ALL ARE SURFACE INSTRUMENTS EXCEPT FOR NALST10 WHICH IS AT 3 METERS DEPTH. A * INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTION OR DAMAGE.

YEAR=2013 MONTH=JANUARY

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	8.1	7.2	10.3	11.0	11.1	12.0	11.9	23.0	19.1	15.5	12.4
HOURLY MEAN	5.7	5.6	7.8	8.6	8.9	10.5	10.8	20.7	16.1	13.3	10.0
HOURLY LOW	3.7	3.6	5.5	6.6	6.9	8.4	9.2	18.7	13.3	10.9	7.8
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2013 MONTH=FEBRUARY

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	7.3	7.5	8.1	8.8	9.3	10.6	10.8	20.8	17.0	14.3	11.1
HOURLY MEAN	5.7	5.4	6.3	7.5	7.8	9.7	10.0	19.5	14.9	12.5	9.6
HOURLY LOW	4.9	4.6	5.5	6.8	7.2	8.7	9.3	18.8	13.4	11.5	8.5
HOURS	672	672	672	672	672	672	672	672	672	672	672

YEAR=2013 MONTH=MARCH

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	10.0	9.7	9.4	10.3	11.3	13.1	12.2	21.9	18.2	15.7	13.1
HOURLY MEAN	7.4	7.1	7.3	8.5	8.8	10.7	11.0	20.2	15.8	13.6	10.6
HOURLY LOW	5.0	5.0	5.3	6.7	7.1	8.9	9.1	18.4	12.8	11.3	8.6
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2013 MONTH=APRIL

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	20.8	21.3	19.9	19.4	19.0	18.7	17.7	27.8	24.1	22.0	18.7
HOURLY MEAN	16.4	16.4	15.7	15.7	15.7	15.7	15.1	24.9	21.0	18.9	15.4
HOURLY LOW	9.0	8.0	8.8	10.0	10.2	11.5	11.4	18.2	17.0	14.9	11.5
HOURS	719	719	719	719	719	719	718	719	719	719	720

YEAR=2013 MONTH=MAY

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	27.3	27.1	25.6	25.1	24.9	25.0	23.3	31.7	28.4	27.1	26.3
HOURLY MEAN	21.3	21.5	20.7	20.2	20.0	19.8	19.2	25.9	23.7	22.5	19.5
HOURLY LOW	18.0	18.0	17.5	17.2	16.8	16.7	15.8	23.0	20.1	19.3	14.2
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2013 MONTH=JUNE

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	30.7	30.5	29.9	29.7	29.6	29.9	28.5	36.2	34.8	32.4	26.4
HOURLY MEAN	26.7	26.9	26.5	26.2	26.1	26.2	25.8	33.6	31.1	29.3	24.3
HOURLY LOW	23.7	24.5	24.1	24.0	23.6	23.3	22.4	31.1	27.4	26.0	23.0
HOURS	720	720	720	720	720	720	720	720	720	720	106

TABLE 3.1-1 (CONT.)

YEAR=2013 MONTH=JULY

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	33.0	32.9	32.9	32.9	32.7	32.8	31.5	38.9	37.0	35.2	*
HOURLY MEAN	29.8	29.9	29.7	29.6	29.5	29.9	29.7	37.2	34.4	32.6	*
HOURLY LOW	27.8	27.9	27.6	27.6	27.3	27.8	27.5	35.6	32.3	30.7	*
HOURS	744	744	744	744	744	744	744	744	744	744	*

YEAR=2013 MONTH=AUGUST

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	29.7	29.9	30.2	30.9	30.6	31.1	30.4	37.4	35.4	33.3	*
HOURLY MEAN	27.6	27.6	28.1	28.3	28.2	29.0	29.2	35.9	33.0	31.1	*
HOURLY LOW	25.5	25.5	26.3	26.7	26.6	27.8	28.1	34.6	31.1	29.2	*
HOURS	744	744	744	744	744	744	744	744	744	744	*

YEAR=2013 MONTH=SEPTEMBER

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	29.3	29.5	29.6	29.7	29.7	29.7	29.3	36.7	34.5	32.3	30.2
HOURLY MEAN	25.6	25.8	26.3	26.4	26.4	26.9	27.0	33.9	30.1	28.6	25.2
HOURLY LOW	21.9	22.0	22.8	23.1	23.4	23.8	24.3	30.9	26.3	25.1	22.6
HOURS	719	720	720	719	719	720	720	718	720	720	464

YEAR=2013 MONTH=OCTOBER

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	24.9	25.0	25.8	26.2	26.1	26.0	25.2	32.2	30.2	28.0	26.0
HOURLY MEAN	19.8	20.1	21.0	21.3	21.6	22.3	22.7	28.2	25.4	23.9	21.5
HOURLY LOW	15.0	15.8	17.2	18.0	18.3	19.6	20.4	25.8	22.6	20.9	17.6
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2013 MONTH=NOVEMBER

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	16.9	17.4	18.7	19.2	19.6	20.3	20.9	26.8	24.4	22.4	20.1
HOURLY MEAN	11.9	12.6	14.3	15.0	15.4	16.7	17.4	24.3	20.3	18.4	15.6
HOURLY LOW	6.3	7.4	9.7	10.6	11.1	12.4	13.2	21.6	16.7	13.7	11.8
HOURS	720	720	720	720	720	720	720	720	720	720	720

YEAR=2013 MONTH=DECEMBER

STATISTIC / STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	10.0	10.0	12.2	12.4	13.1	13.5	14.0	25.7	20.5	16.5	13.9
HOURLY MEAN	6.4	6.6	8.8	9.5	10.0	11.5	12.4	22.9	17.3	14.3	11.6
HOURLY LOW	4.6	4.7	6.9	7.7	8.4	9.8	11.2	21.4	15.2	12.9	10.0
HOURS	744	744	744	744	744	744	744	744	743	744	744

The instantaneous temperature surveys were conducted in March, May, August, and December to provide temperature data to assess seasonal thermal stratification patterns in the lake (Table 3.1-2). Results of the March survey show a maximum temperature decrease of 3.6°C from surface to bottom with very little stratification. The May survey shows a thermocline (a layer within a body of water where the temperature changes rapidly with depth) forming at the 14 to 15 meter depths at Station A up lake to Station G. Beyond that point, in the middle and upper lake, a thermocline was less pronounced as indicated by more gradual changes in temperatures from surface to bottom. The August survey shows very minimal temperature change with depth, while the December survey shows a slight decrease in temperature with decreasing depth.

Table 3.1-2	Lake Anna water temperatures from the instantaneous temperature surveys in (°C) measured at one meter interval depths														
3/12/2013	Depth (m)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
MARCH	0	11.2	11.2	10.9	10.2	9.9	11.0	10.7	10.4	9.1	9.6	8.7	7.0	7.8	8.7
	1	11.1	11.2	10.8	10.1	9.9	10.9	10.6	10.3	9.1	9.4	8.3	7.1	7.7	8.5
	2	11.1	11.2	10.7	10.1	9.9	10.6	10.5	9.9	8.9	9.3	8.0	7.0	7.3	8.1
	3	11.0	11.2	10.6	10.0	9.8	10.4	10.5	9.9	8.9	9.3	7.8	7.0	6.8	7.9
	4	10.9	11.1	10.4	9.9	9.6	10.3	10.5	9.4	8.8	9.2	7.7	6.7	6.7	7.9
	5	10.7	11.1	10.2	9.8	9.5	10.3	10.5	8.7	8.8	9.1	7.5	6.7	6.4	7.4
	6	10.4	10.9	10.1	9.6	9.4	10.2	10.5	8.6	8.8	8.9	7.4	6.7	6.1	7.2
	7	9.6	10.9	10.1	9.5	9.4	10.1	10.5	8.6	8.6	8.8	7.1	6.6	5.7	6.2
	8	9.3	10.9	9.9	9.4	9.4	10.1	10.1	8.3	8.4	8.8	6.7		5.6	
	9	9.1	10.8	9.8	9.2	9.4	9.6	9.6	8.1	8.3	8.6	6.5			
	10	9.0	10.3	9.7	9.2	9.4	8.5	9.3	7.7	8.2	7.9	6.4			
	11	9.0	10.2	9.6	9.1	9.3	8.4	9.1	7.2	8.2	7.8	6.4			
	12	9.0	9.9	9.5	9.1	9.2	7.7	8.5	6.9	8.0	7.6	6.3			
	13	9.0	9.9	9.4	9.0	9.2	7.7	7.3	6.9	7.9	7.3	6.3			
	14	9.0	9.8	9.3	9.0	9.1	7.6	7.3	6.8		7.2	6.2			
	15	9.0	9.4	9.1	8.9	9.1	7.5	7.2	6.8			6.2			
	16	9.0	9.4	9.0	8.8	9.0	7.5	7.2							
	17	9.0	9.2	9.0	8.8	9.0	7.5	7.1							
	18	9.0	9.2	9.0	8.7	8.7	7.5	7.1							
	19	8.9		8.9	8.7		7.5	7.1							
	20	9.0					7.5								

Warm Cool

Table 3.1-2 (cont.)	Lake Anna water temperatures from the instantaneous temperature surveys in (°C) measured at one meter interval depths														
5/17/2013	Depth	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	0	22.2	21.1	22.4	21.9	21.6	22.6	22.0	22.3	22.6	22.3	22.4	23.2	23.6	23.1
	1	21.3	20.7	21.5	21.0	21.2	22.1	21.4	21.6	21.8	21.6	22.3	22.5	23.4	22.9
	2	20.6	20.5	20.6	20.8	20.7	21.2	21.2	21.2	21.3	20.4	21.1	20.6	22.8	21.8
	3	20.5	20.2	20.4	20.3	20.2	20.4	20.9	20.5	19.9	20.2	20.5	19.9	19.8	20.8
	4	20.4	19.1	20.3	20.0	19.8	20.2	19.9	20.1	19.5	19.9	20.0	19.3	19.2	19.5
	5	20.2	18.8	19.7	19.8	19.6	19.9	19.8	19.9	19.0	19.6	20.0	18.4	18.5	18.7
	6	20.1	18.3	19.4	19.5	19.5	19.9	19.5	19.7	18.8	19.3	19.6	17.5	17.5	17.9
	7	20.0	17.3	19.3	19.4	19.4	19.8	19.3	19.5	18.7	18.7	19.1	17.5	16.5	17.3
M	8	20.0	16.9	19.3	19.4	19.2	19.5	18.9	18.9	18.3	18.0	18.0		16.2	
	9	18.7	16.3	19.0	19.2	19.1	19.2	18.4	18.4	17.6	17.3	17.6			
A	10	18.5	14.9	18.7	18.8	18.8	18.8	17.9	18.1	16.7	17.1	17.1			
	11	18.3	13.2	16.4	17.5	18.1	18.5	17.3	16.6	16.5	15.9	16.8			
Y	12	17.6	12.7	14.1	15.0	16.4	16.8	16.2	15.8	16.2	15.6	16.3			
	13	15.4	12.3	12.8	13.6	15.1	16.2	15.9	14.6	15.9	14.0	14.9			
	14	13.4	12.2	12.4	13.0	13.2	14.7	13.5	13.9		12.8	14.5			
	15	12.2		12.0	12.4	12.8	13.8	12.9	13.6			14.1			
	16	11.8		11.6	12.1	12.6	13.5	12.8				13.7			
	17	11.6		11.5	11.7	12.2	12.6	12.7							
	18	11.7		11.5	11.6		12.3	12.7							
	19	11.5					12.2	12.6							
	20						11.7								

Warm Cool

Table 3.1-2 (cont.)	Lake Anna water temperatures from the instantaneous temperature surveys in (°C) measured at one meter interval depths														
8/21/2013	Depth	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	0	28.8	28.8	28.7	28.7	28.7	29.2	28.8	28.8	28.1	27.9	27.8	27.0	27.7	27.4
	1	28.7	28.8	28.6	28.5	28.6	28.8	28.6	28.0	27.5	27.8	27.3	26.8	26.9	26.8
	2	28.6	28.7	28.5	28.4	28.4	28.4	28.5	27.2	27.3	27.7	27.2	26.4	26.6	26.4
	3	28.6	28.6	28.5	28.1	28.2	28.2	28.4	26.9	27.1	27.5	27.1	26.3	25.8	25.9
	4	28.5	28.5	27.8	27.7	27.7	28.2	28.3	26.9	27.0	27.4	27.0	26.1	25.5	25.2
A	5	28.4	28.3	27.6	27.6	27.7	28.2	28.0	26.9	26.9	27.3	26.3	26.1	25.0	24.3
	6	28.3	28.1	27.6	27.6	27.7	28.1	27.6	26.8	26.9	27.2	26.1	26.0	23.3	23.3
u	7	27.8	27.9	27.5	27.6	27.6	27.9	27.4	26.8	26.9	27.1	26.1	26.0	22.8	23.2
	8	27.6	27.9	27.5	27.5	27.5	27.4	27.2	26.8	26.9	26.7	26.0	25.9		
g	9	27.5	27.8	27.5	27.5	27.5	27.4	27.1	26.7	26.7	26.6	26.0	25.8		
	10	27.6	27.7	27.5	27.5	27.5	27.3	27.1	26.7	26.5	26.5	25.9	25.7		
u	11	27.4	27.4	27.4	27.4	27.4	27.2	27.0	26.6	26.5	26.3	25.2			
	12	27.3	27.3	27.4	27.4	27.3	27.1	27.0	26.6	26.4	26.1	25.1			
	13	27.3	27.3	27.3	27.3	27.3	27.1	26.9	26.5	26.2	26.1	24.9			
s	14	27.2	27.3	27.3	27.3	27.2	27.0	26.4	26.3		26.0	24.9			
	15	27.0	27.2	27.2	27.3	27.1	26.9	26.7	26.3			24.9			
t	16	26.7	27.2	27.1	27.1	26.9	26.8	26.5							
	17	25.9		26.8	27.0	26.8	26.7	26.3							
	18	24.4		24.2	26.1	26.6	26.1	26.0							
	19	21.8		22.6	22.1		24.6	25.8							
	20	19.8					21.3								
	21	17.0													

Warm Cool

Table 3.1-2 (cont.) Lake Anna water temperatures from the instantaneous temperature surveys in (°C) measured at one meter interval depths

12/27/2013	Depth	A	B	C	D	E	F	G	H	I	J	K	L	M	N
December	0	12.0	11.9	11.6	11.0	10.9	10.9	10.0	9.4	9.2	9.2	8.1	7.1	7.0	6.7
	1	12.0	11.9	11.6	11.0	10.9	10.9	10.0	9.4	9.2	9.2	8.0	7.0	7.0	6.3
	2	11.9	11.9	11.6	11.0	10.8	10.8	10.0	9.4	9.0	9.1	7.9	6.8	6.3	6.3
	3	11.8	11.9	11.6	11.0	10.8	10.8	10.0	9.4	8.9	9.0	7.9	6.8	6.3	6.2
	4	11.4	11.8	11.5	10.9	10.8	10.7	10.0	9.4	8.9	9.0	7.9	6.8	6.2	6.2
	5	11.4	11.8	10.8	10.7	10.8	10.7	9.8	9.3	8.9	9.0	7.8	6.8	6.2	6.1
	6	11.7	11.6	10.8	10.6	10.7	10.7	9.8	9.2	8.9	8.8	7.7	6.8	6.2	6.1
	7	11.7	11.5	10.4	10.4	10.5	10.7	9.6	9.0	8.8	8.7	7.6	6.8	6.2	6.1
	8	11.3	11.5	10.4	10.4	10.5	10.6	9.6	9.0	8.8	8.7	7.5		6.4	
	9	11.2	11.4	10.4	10.4	10.5	10.5	9.6	9.0	8.8	8.7	7.5			
	10	10.7	11.0	10.4	10.4	10.4	9.8	9.5	9.8	8.7	8.6	7.5			
	11	10.8	10.9	10.3	10.2	10.3	9.8	9.5	8.9	8.6	8.5	7.4			
	12	10.6	10.9	10.3	10.2	10.3	9.8	9.5	8.9	8.4	8.3	7.4			
	13	10.5	10.9	10.3	10.2	10.3	9.7	9.5	8.9	8.3	8.3	7.4			
	14	10.5	10.9	10.3	10.2	10.3	9.7	9.4	8.9		8.1	7.5			
	15	10.5	10.9	10.3	10.2	10.2	9.6	9.3	8.8			7.5			
	16	10.5	10.8	10.3	10.2	10.2	9.6	9.2							
	17	10.5		10.3	10.2	10.0	9.5	9.0							
	18	10.4		10.3	10.2	10.0	9.5	9.0							
	19	10.4		10.3	10.2		9.5	8.9							
	20	10.4					9.5								
	21	10.3													

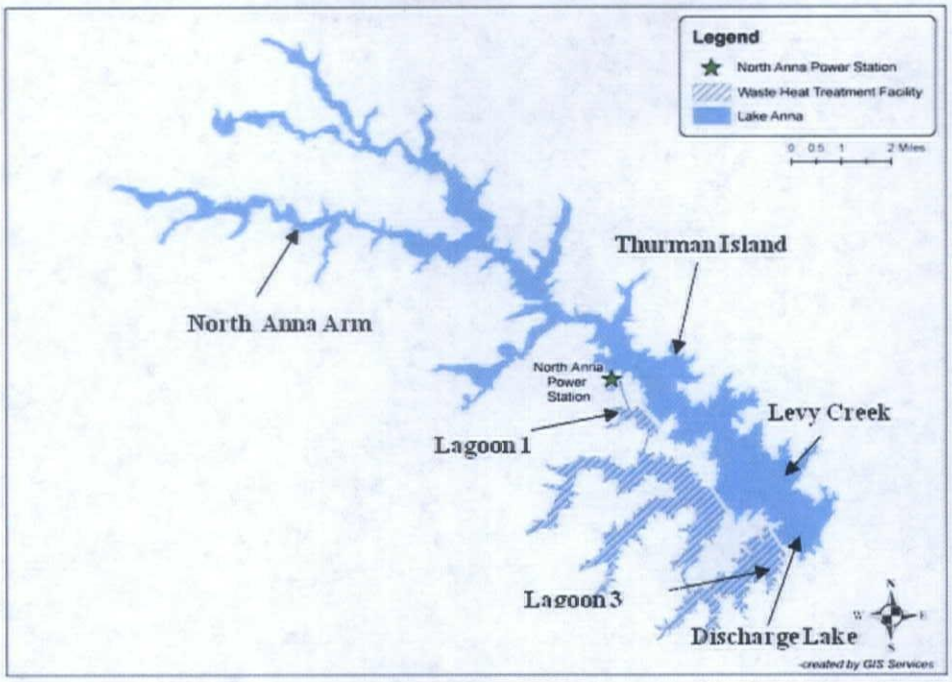
Warm — Cool

3.2 Fish Population Studies - Gill Netting

Methods

The monitoring of fish abundance and species composition for Lake Anna and the WHTF continued in 2013 using the same sampling methods as previous years, gill netting and boat electrofishing. Gill netting was used to capture fishes which normally inhabit the deeper strata of the lake, or exhibit a movement to and from the shoreline within a 24-hour period. Similar to previous years, gill net surveys for 2013 were conducted seasonally (February, May, August, and November) at each of six stations (Figure 3.2-1). Gill nets were set near littoral (near the shoreline) drop-off areas and left overnight. Standard physicochemical measurements including surface water temperature (°C), dissolved oxygen (mg/l), pH and conductivity (umhos) were recorded at the time of

Figure 3.2-1 Location of gill netting stations on Lake Anna and WHTF



each sample collection. Fish collected by gill netting were returned to the laboratory for processing. Length (mm) and weight (g) were recorded for each fish. The fish for each sample were sorted by species and enumerated. Catch per unit effort (CPUE) was calculated as the number of fish per net night. CPUE for 2013 was compared to historical average CPUE using a one sample t-test with a 95% confidence interval (CI).

Results and Discussion

Standard physicochemical measurements recorded during gill net surveys are shown in Table 3.2-1. The data demonstrate expected seasonal changes in temperature and dissolved oxygen, while conductivity and pH were relatively stable. The data are consistent with historical trends and indicate that these water quality parameters in Lake Anna and the WHTF are within the values to support a healthy fishery.

Table 3.2-1 Surface water temperature (C°), conductivity (umhos), pH (standard units) and dissolved oxygen (mg/l) recorded at time of gill net sampling during 2013

February

Gill netting Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF	20.2	58	7.0	11.09
LAGOON 3 WHTF	13.4	57	6.8	10.3
DIKE3 DISCHARGE LAKE	11.5	56	7.2	10.5
LEVY CREEK	9.8	56	7.0	10.9
NORTH ANNA ARM	5.5	65	6.9	11.7
THURMAN ISLAND	7.8	56	7.0	11.5

May

Gill netting Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF	23.6	60	6.5	9.0
LAGOON 3 WHTF	22.4	59	6.5	8.8
DIKE3 DISCHARGE LAKE	20.4	60	6.5	8.3
LEVY CREEK	20.3	60	6.5	8.8
NORTH ANNA ARM	20.3	60	6.9	9.0
THURMAN ISLAND	19.7	59	6.8	9.4

August

Gill netting Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF	36.5	62	7.1	6.6
LAGOON 3 WHTF	32.8	61	7.5	7.5
DIKE3 DISCHARGE LAKE	30.0	63	7.0	6.0
LEVY CREEK	29.5	62	7.2	6.3
NORTH ANNA ARM	27.7	64	7.3	8.6
THURMAN ISLAND	28.5	61	7.0	6.5

November

Gill netting Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF	23.3	62	7.3	9.0
LAGOON 3 WHTF	19.1	59	7.1	8.8
DIKE3 DISCHARGE LAKE	17.0	61	7.2	8.7
LEVY CREEK	15.7	61	7.0	9.2
NORTH ANNA ARM	11.5	64	6.7	11.2
THURMAN ISLAND	14.8	60	6.7	9.3

Nineteen species of fish representing seven families were collected in Lake Anna and the WHTF by quarterly gill netting in 2013 (Table 3.2-2).

Table 3.2-2 Fishes collected in Lake Anna and the WHTF by gill netting during 2013

FAMILY	SPECIES	LAKE	WHTF
Catostomidae	*Carpiodes cyprinus*		x
	Moxostoma macrolepidotum	x	
Centrarchidae	*Lepomis macrochirus*	x	x
	Lepomis microlophus	x	x
	Micropterus salmoides	x	x
	Pomoxis nigromaculatus	x	x
Clupeidae	*Dorosoma cepedianum*	x	x
	Dorosoma petenense	x	x
Cyprinidae	*Cyprinella analostana*	x	
	Cyprinus carpio	x	x
	Notropis hudsonius	x	x
Ictaluridae	*Ameiurus catus*	x	x
	Ameiurus natalis	x	
	Ictalurus furcatus		x
	Ictalurus punctatus	x	x
Moronidae	*Morone americana*	x	x
	Morone saxatilis	x	x
Percidae	*Perca flavescens*	x	
	Sander vitreus	x	

Table 3.2-3 presents the gill net catch data by species and season at lake stations in 2013. The numerically dominant species collected in the lake were White Perch *Morone americana*, Gizzard Shad *Dorosoma cepedianum*, Channel Catfish *Ictalurus punctatus*, Black Crappie *Pomoxis nigromaculatus* and Striped Bass *Morone saxatilis*. These five species represented 82% of the gill net catch by number.

Table 3.2-3 Gill net summary for pooled lake stations during 2013; Number and Weight (g)

	FEBRUARY		MAY		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
Morone americana	21	1117.0	31	3297.0	12	752.3	69	1440.0	133	6606	23%	4%
Dorosoma cepedianum	9	2487.0	24	6118.0	69	7564.8	16	2943.0	118	19113	20%	11%
Ictalurus punctatus	22	5773.0	31	12815.0	22	6351.0	14	8067.0	89	33006	15%	19%
Pomoxis nigromaculatus	6	622.0	9	441.0	62	4642.0	1	217.0	78	5922	14%	3%
Morone saxatilis	13	10672.0	11	8082.0	11	4798.0	20	21831.0	55	45383	10%	26%
Ameiurus catus	16	2282.0	10	1017.0	9	865.9	7	962.0	42	5127	7%	3%
Micropterus salmoides	2	2193.0	3	1993.0	7	2345.4	5	2436.0	17	8967	3%	5%
Cyprinus carpio	2	7659.0	5	15140.0	6	19683.0	1	3065.0	14	45547	2%	26%
Dorosoma petenense	1	6.0			7	63.1	5	41.0	13	110	2%	0%
Moxostoma macrolepidotum					4	3611.0	2	1860.0	6	5471	1%	3%
Lepomis macrochirus					2	41.4	1	7.0	3	48	1%	0%
Ameiurus natalis			1	426.0					1	426	0%	0%
Cyprinella analostana			1	8.0			1	11.0	2	19	0%	0%
Lepomis microlophus							1	150.0	1	150	0%	0%
Notropis hudsonius			1	19.0					1	19	0%	0%
Perca flavescens							1	10.0	1	10	0%	0%
Sander vitreus							1	198.0	1	198	0%	0%
Totals	**93**	**32,811**	**127**	**49,356**	**211**	**50,718**	**145**	**43,238**	**576**	**176,123**	**100%**	**100%**

The numerically dominant species collected by gill netting in the WHTF in 2013 were Gizzard Shad followed by Channel Catfish, White Perch, Striped Bass and Common Carp *Cyprinus carpio* (Table 3.2-4). Together these species represented 84% of the number of fish collected.

Table 3.2-4 Gill net summary for pooled WHTF stations during 2013; Number and Weight (g)

	FEBRUARY		MAY		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
Dorosoma cepedianum	31	12532.0	33	12061.0	15	4656.0	22	8725.0	101	37974	35%	23%
Ictalurus punctatus	21	23952.7	15	10149.0	21	8155.0	6	1069.0	63	43326	22%	26%
Morone americana	12	1533.0	4	133.0	2	132.0	21	826.0	39	2624	13%	2%
Morone saxatilis	7	8176.0	12	10649.0			4	3066.0	23	21891	8%	13%
Cyprinus carpio	5	11490.0	10	24768.0			3	3267.0	18	39525	6%	24%
Ameiurus catus	4	578.0	1	166.0			10	1239.0	15	1983	5%	1%
Micropterus salmoides	3	2773.0	1	209.0	8	2130.0	1	486.0	13	5598	4%	3%
Dorosoma petenense			5	42.0			2	17.0	7	59	2%	0%
Pomoxis nigromaculatus	3	1397.0							3	1397	1%	1%
Carpiodes cyprinus							2	3129.0	2	3129	1%	2%
Lepomis microlophus			1	137.0	1	143.0			2	280	1%	0%
Ictalurus furcatus							1	7000.0	1	7000	0%	4%
Lepomis macrochirus					1	43.0			1	43	0%	0%
Notropis hudsonius			1	11.0					1	11	0%	0%
Totals	**86**	**62,432**	**83**	**58,325**	**48**	**15,259**	**72**	**28,824**	**289**	**164,840**	**100%**	**100%**

The 2013 CPUE (#/net night) for the top 5 gill net species for the lake and WHTF were compared to their 1981-2012 historical averages and are presented in table 3.2-5.

Table 3.2-5 CPUE (# per net night) for the top 5 species, 1981-2012 averages and p-values (1 sample T-test; 95%CI) for gill netting samples in the Lake and WHTF

Lake

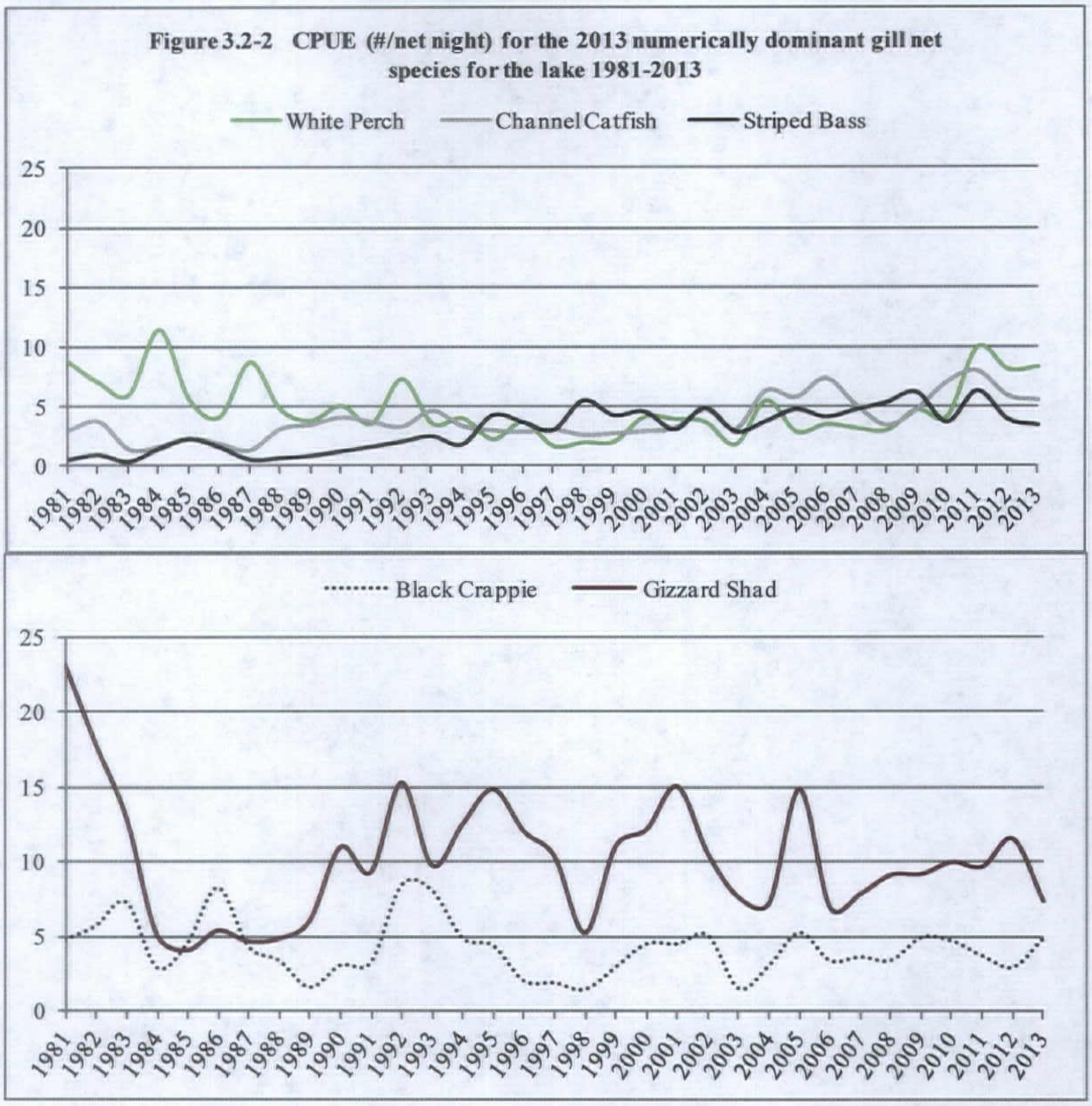
Species	2013 CPUE	81-'12 Average CPUE	CPUE(p-value)
Morone americana	8.31	4.81	0.000
Dorosoma cepedianum	7.38	10.25	0.001
Ictalurus punctatus	5.56	3.82	0.000
Pomoxis negromaculatus	4.88	4.17	0.040
Morone saxatilis	3.44	3.05	0.217

WHTF

Species	2013 CPUE	81-'12 Average CPUE	CPUE (p-value)
Dorosoma cepedianum	12.63	8.92	0.000
Ictalurus punctatus	7.88	10.45	0.004
Morone americana	4.88	3.73	0.013
Morone saxatilis	2.88	1.01	0.000
Cyprinus carpio	2.25	1.62	0.013

In the lake, White Perch, Channel Catfish and Black Crappie had a CPUE that was significantly higher than the 1981-2012 average. Striped bass CPUE for 2013 was higher than the historical average but the difference was not significant. Gizzard Shad CPUE was significantly lower than the 1981-2012 average.

In the WHTF, Gizzard Shad, White Perch, Striped Bass and Common Carp had a CPUE that was significantly higher than the historical average. Channel Catfish had a CPUE that was significantly lower than the historical average. The CPUE for the 2013 numerically dominant gill net species in the lake and WHTF are displayed graphically from 1981-2013 in Figure 3.2-2 and Figure 3.2-3.



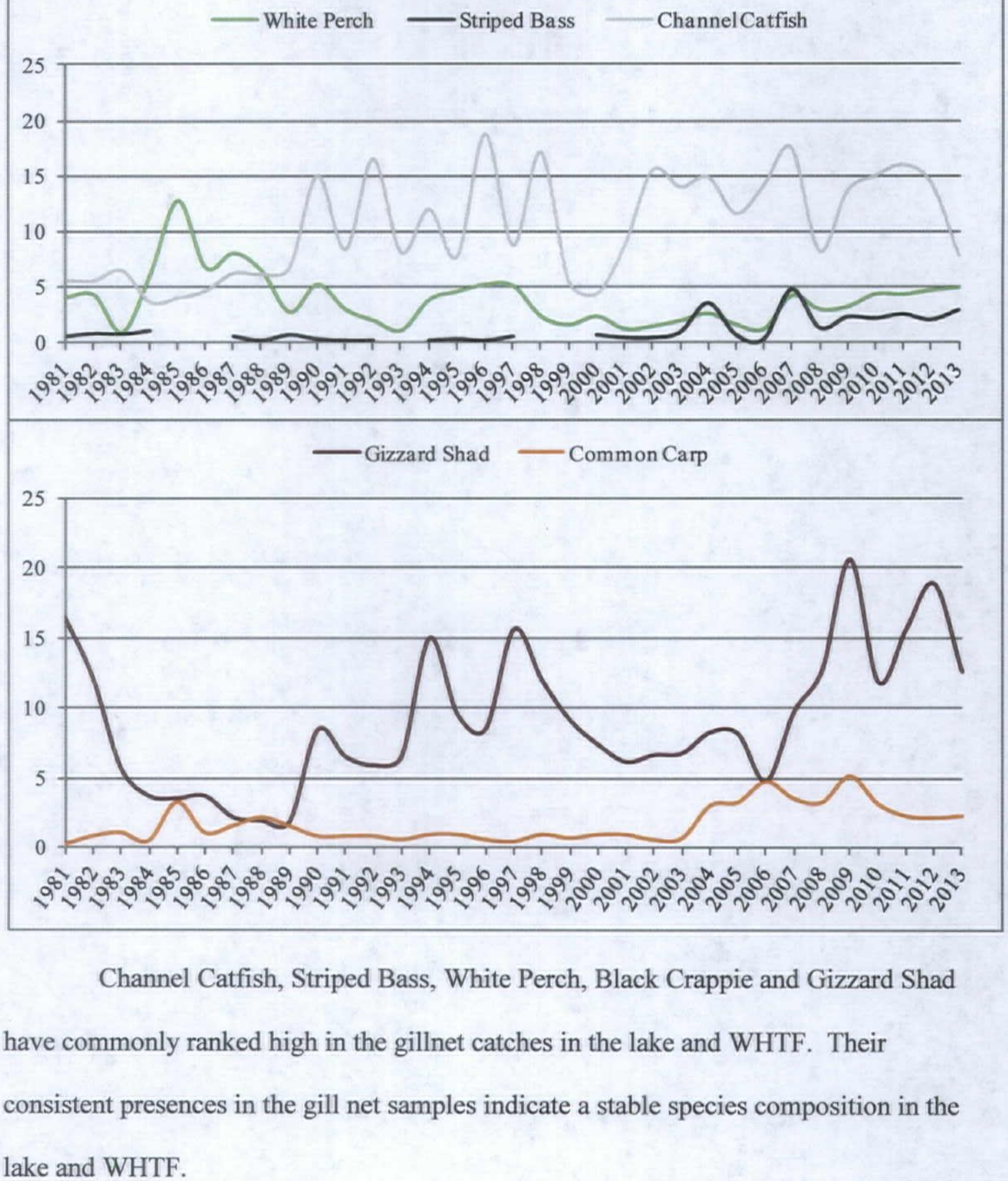
Over the last 32 years, Striped Bass and Channel Catfish catch rates have been slowly increasing in the lake. White perch catch rates were declining from 1981-1994 but have been increasing ever since (Figure 3.2-2). Striped bass recruitment is driven by the DGIF stocking program while white perch and channel catfish reproduce naturally in the lake.

Black Crappie and Gizzard Shad catches at the lake stations show high annual variability, yet have a consistent presence in lake gill net samples. Black Crappie and

Gizzard Shad gill net catch rates seem to increase and decrease together as seen in Figure 3.2-2. To test for a relationship, the CPUE for Black Crappie and Gizzard Shad were compared using a regression analysis with an alpha level of 0.05. Although ecological niches of Black Crappie and Gizzard Shad may overlap slightly in Lake Anna, there does not seem to be a statistically significant relationship between their relative abundance ($p=0.085$). In the WHTF, channel catfish have shown a highly variable catch rate over time. White Perch and Striped bass catches appear to be slowly increasing over the last few years (Figure 3.2-3).

Gizzard shad gill net catch rates in the WHTF are highly variable, as in the lake, and appear to be slowly increasing over time (Figure 3.2-3). Gizzard shad are pelagic (open water) schooling species. Large schools of shad can inflate the CPUE causing large fluctuations in catches among years. Common Carp have been a consistent member of the gill net catch. High carp densities have been known to cause ecological harm in shallow lakes and ponds by increasing turbidity and lowering macrophyte (plant) production through their feeding habits. Common carp are omnivorous and feed on benthic organisms, algae, terrestrial insects and aquatic plants (Jenkins 1993) which causes the stirring up of silt and uprooting of aquatic plants. Although there is a steady presence of in the WHTF, we have not observed evidence of these ecological impacts from the carp.

Figure 3.2-3 CPUE (#/net night) for the 2013 numerically dominant gill net species for the WHTF 1981-2013



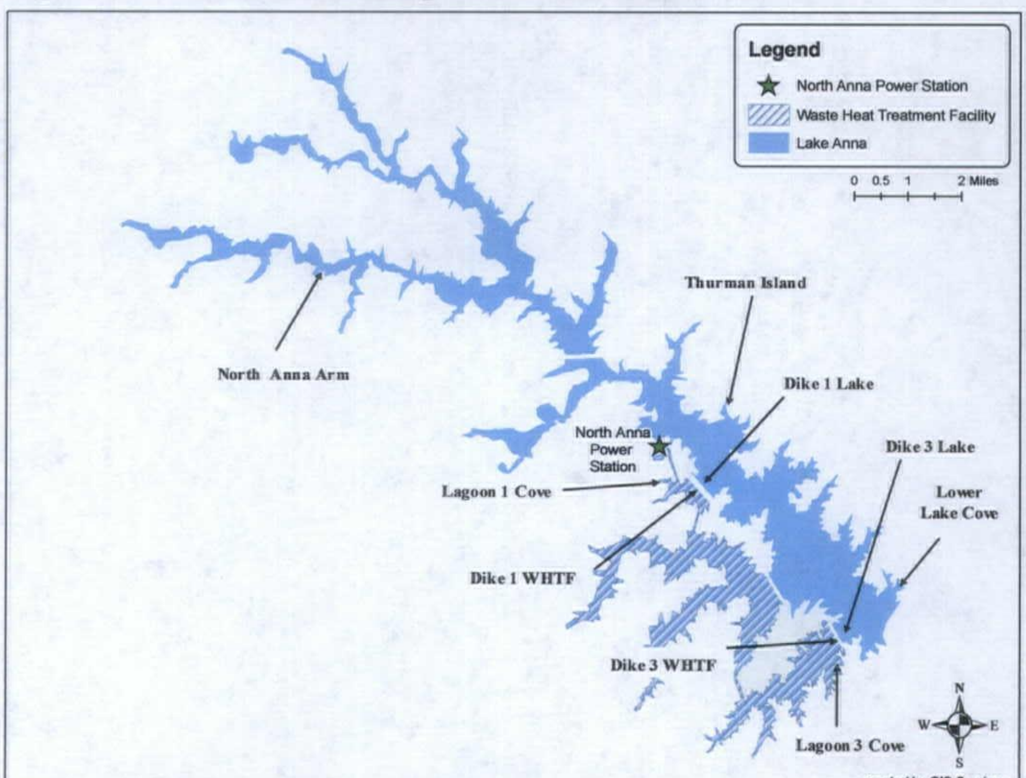
Channel Catfish, Striped Bass, White Perch, Black Crappie and Gizzard Shad have commonly ranked high in the gillnet catches in the lake and WHTF. Their consistent presences in the gill net samples indicate a stable species composition in the lake and WHTF.

3.3 Fish Population Studies - Electrofishing

Methods

Boat electrofishing was used in 2013 to evaluate the assemblage and abundance of fish populations which normally occupy the shoreline habitat. Sampling was conducted in February, May, August, and November at each station (Figure 3.3-1). Each station is 100 meters in length and is sampled by electrofishing for approximately 10 minutes. Sampling stations normally include a brush pile except for the dike stations which are comprised of uniform rip-rap. It has been observed that the brush piles have degraded at some of the electrofishing stations including Lagoon 1 Cove, North Anna Arm and Lower Lake Cove. The reduction of brush piles has altered the habitat available for fish which may affect electrofishing results. Standard physicochemical measurements of surface water temperature (°C), dissolved oxygen (mg/l), pH and

Figure 3.3-1 Locations of electrofishing stations on Lake Anna and WHTF



conductivity (µmhos) were recorded at the time of each sample collection.

All fish collected were either returned to the laboratory for processing or released in the field, i.e., larger game fish were measured, weighed, and released in the field. In the laboratory, fish were sorted by species and up to 25 individuals per species from each station were measured for total length (mm) and weighed (g). The remaining fish (per species) were enumerated and bulk weighed. CPUE was calculated as the number of fish collected per hour of electrofishing. CPUE for 2013 was compared to historical averages of CPUE using a one sample t-test with a 95% CI.

Results and Discussion

Physicochemical measurements recorded at each station during electrofishing surveys are presented in Table 3.3-1. Seasonal changes in water temperatures and dissolved oxygen were noticeable and expected while conductivity and pH remained relatively stable. The data are consistent with historical trends and indicate that these water quality parameters in Lake Anna and the WHTF are within the values to support a

Table 3.3-1 Surface water temperature (C°), conductivity (umhos), pH (standard units) and dissolved oxygen (mg/l) recorded at time of electrofishing sampling during 2013

February

Electrofishing Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF COVE	19.64	58	6.90	11.0
LAGOON 1 WHTF DIKE	19.84	58	6.88	10.9
LAGOON 3 WHTF COVE	13.33	57	6.80	10.3
LAGOON 3 WHTF DIKE	13.00	57	8.00	10.4
DIKE 1 LAKE	7.75	56	7.00	11.3
DIKE 3 LAKE	10.98	57	7.20	10.7
LOWER LAKE COVE	9.93	57	6.85	10.8
NORTH ANNA ARM	5.15	66	6.50	11.6
THURMAN ISLAND	7.64	56	6.90	11.5

May

Electrofishing Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF COVE	23.02	60	6.93	9.0
LAGOON 1 WHTF DIKE	23.00	60	6.82	8.9
LAGOON 3 WHTF COVE	22.28	59	6.50	8.7
LAGOON 3 WHTF DIKE	21.89	60	6.90	8.7
DIKE 1 LAKE	21.00	60	6.90	8.7
DIKE 3 LAKE	19.57	60	6.30	8.1
LOWER LAKE COVE	21.85	60	6.80	8.5
NORTH ANNA ARM	19.36	59	6.90	9.7
THURMAN ISLAND	20.27	59	6.80	9.1

August

Electrofishing Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF COVE	34.94	62	7.30	6.5
LAGOON 1 WHTF DIKE	35.70	61	7.30	6.4
LAGOON 3 WHTF COVE	32.84	61	7.50	7.6
LAGOON 3 WHTF DIKE	32.45	61	7.50	7.5
DIKE 1 LAKE	28.30	62	7.10	6.0
DIKE 3 LAKE	30.50	62	7.20	6.3
LOWER LAKE COVE	29.60	62	7.10	6.7
NORTH ANNA ARM	27.60	65	7.50	8.7
THURMAN ISLAND	27.70	64	7.30	8.6

November

Electrofishing Stations	Temperature	Conductivity	pH	Dissolved Oxygen
LAGOON 1 WHTF COVE	23.60	58	7.20	9.2
LAGOON 1 WHTF DIKE	23.11	62	7.30	9.5
LAGOON 3 WHTF COVE	19.12	59	7.10	9.0
LAGOON 3 WHTF DIKE	17.98	61	7.10	8.8
DIKE 1 LAKE	13.99	60	6.70	9.5
DIKE 3 LAKE	17.10	61	7.20	8.7
LOWER LAKE COVE	15.70	61	7.20	9.4
NORTH ANNA ARM	10.56	65	7.10	11.1
THURMAN ISLAND	14.22	60	6.90	9.2

healthy fishery.

Twenty-three species of fish representing nine families were collected by electrofishing in the lake and WHTF in 2013 (Table 3.3-2).

Table 3.3-2 Fishes collected in Lake Anna and the WHTF by electrofishing during 2013

FAMILY	SPECIES	LAKE	WHTF
Anguillidae	*Anguilla rostrata*	x	
Centrarchidae	*Lepomis auritus*	x	x
	Lepomis cyanellus	x	x
	Lepomis gibbosus	x	
	Lepomis gulosus	x	x
	Lepomis macrochirus	x	x
	Lepomis microlophus	x	x
	Micropterus salmoides	x	x
	Pomoxis nigromaculatus	x	
Clupeidae	*Alosa pseudoharengus*	x	
	Dorosoma cepedianum	x	x
	Dorosoma petenense	x	
Cyprinidae	*Cyprinus carpio*	x	
	Notropis hudsonius	x	x
	Notropis procne	x	x
Cyprinodontidae	*Fundulus diaphanus*	x	
Ictaluridae	*Ameiurus catus*	x	
	Ameiurus natalis	x	x
	Ameiurus nebulosus	x	
	Ictalurus punctatus	x	x
Moronidae	*Morone americana*	x	
Percidae	*Perca flavescens*	x	
Poeciliidae	*Gambusia holbrooki*		x

Table 3.3-3 presents the gill net catch data by species and season at lake stations in 2013. The numerically dominant species collected in the lake were Bluegill *Lepomis macrochirus*, Largemouth Bass *Micropterus salmoides*, Green Sunfish *Lepomis cyanellus*, Threadfin Shad *Dorosoma petenense* and Redear Sunfish *Lepomis microlophus*. These 5 species represented 91% of the electrofishing catch by number.

Table 3.3-3	Electrofishing summary for pooled lake stations during 2013; Number and Weight (g)											
	FEBRUARY		**MAY**		**AUGUST**		**NOVEMBER**		**TOTALS**		**% OF TOTAL**	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
Lepomis macrochirus	625	11914.3	175	1983.4	139	2268.9	1054	15265.3	1993	31432	73%	34%
Micropterus salmoides	69	19960.4	20	9446.5	17	2166.8	46	5045.0	152	36619	6%	40%
Lepomis cyanellus	58	667.2	27	412.3	16	428.1	42	769.0	143	2277	5%	2%
Dorosoma petenense					91	122.6			91	123	3%	0%
Lepomis microlophus	44	2099.9	12	567.8	3	195.8	31	664.7	90	3528	3%	4%
Lepomis auritus	16	1225.7	11	408.7	9	238.2	36	1679.6	72	3552	3%	4%
Lepomis gulosus	14	878.8	8	393.8	4	113.4	33	862.0	59	2248	2%	2%
Perca flavescens			6	229.0	19	598.0	13	174.0	38	1001	1%	1%
Ameiurus catus					17	449.9	1	17.0	18	467	1%	1%
Dorosoma cepedianum	1	336.0	2	244.0	13	1686.9	1	422.0	17	2689	1%	3%
Pomoxis nigromaculatus			9	1856.0	3	194.0	4	49.0	16	2099	1%	2%
Morone americana			4	253.0	5	234.0	2	20.0	11	507	0%	1%
Alosa pseudoharengus					4	2.1			4	2	0%	0%
Fundulus diaphanus	2	5.9			2	4.3			4	10	0%	0%
Lepomis gibbosus			1	12.2			3	113.0	4	125	0%	0%
Ictalurus punctatus			1	472.0	2	218.2			3	690	0%	1%
Notropis hudsonius	2	14.2			1	1.4			3	16	0%	0%
Ameiurus nebulosus			2	66.5					2	67	0%	0%
Notropis procne	2	2.6							2	3	0%	0%
Ameiurus natalis			1	350					1	350	0%	0%
Anguilla rostrata			1	750					1	750	0%	1%
Cyprinus carpio					1	3550			1	3550	0%	4%
Totals	**833**	**37,105**	**280**	**17,445**	**346**	**12,473**	**1,266**	**25,081**	**2,725**	**92,103**	**100%**	**100%**

The numerically dominant species collected by electrofishing in the WHTF in 2013 were Bluegill, Largemouth Bass, Green Sunfish, Redear Sunfish and Channel Catfish. Together these species represented 98% of the number of fish collected.

Table 3.3-4	Electrofishing summary for pooled WHTF stations during 2013; Number and Weight (g)											
	FEBRUARY		**MAY**		**AUGUST**		**NOVEMBER**		**TOTALS**		**% OF TOTAL**	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
Lepomis macrochirus	173	2539.1	108	3750.7	59	813.0	650	8650.2	990	15753	83%	53%
Micropterus salmoides	23	3601.0	15	1795.0	6	66.4	17	1777.1	61	7240	5%	24%
Lepomis cyanellus	9	175.1	9	103.9	9	94.4	31	280.6	58	654	5%	2%
Lepomis microlophus	13	218.6	4	80.6	1	28.6	23	474.0	41	802	3%	3%
Ictalurus punctatus	2	574.0	8	2427.0	3	1012.0	5	107.0	18	4120	2%	14%
Lepomis auritus	2	72.3			5	68.7	6	125.3	13	266	1%	1%
Lepomis gulosus	1	116.0	1	119.0	2	64.2	4	50.9	8	350	1%	1%
Notropis hudsonius			2	4.2					2	4	0%	0%
Ameiurus natalis							1	44.0	1	44	0%	0%
Dorosoma cepedianum							1	452.0	1	452	0%	2%
Gambusia holbrooki							1	0.1	1	0	0%	0%
Notropis procne	1	1.5							1	2	0%	0%
Totals	**224**	**7,298**	**147**	**8,280**	**85**	**2,147**	**739**	**11,961**	**1,195**	**29,687**	**100%**	**100%**

The 2013 CPUE for the numerically dominant electrofishing species for the lake and WHTF were compared to their 1981-2012 historical averages in Table 3.3-5.

Table 3.3-5 CPUE (#/hr) for the top 5 species, 1981-2012 averages and p-values (1 sample T-test; 95%CI) for electrofishing samples in the Lake and WHTF

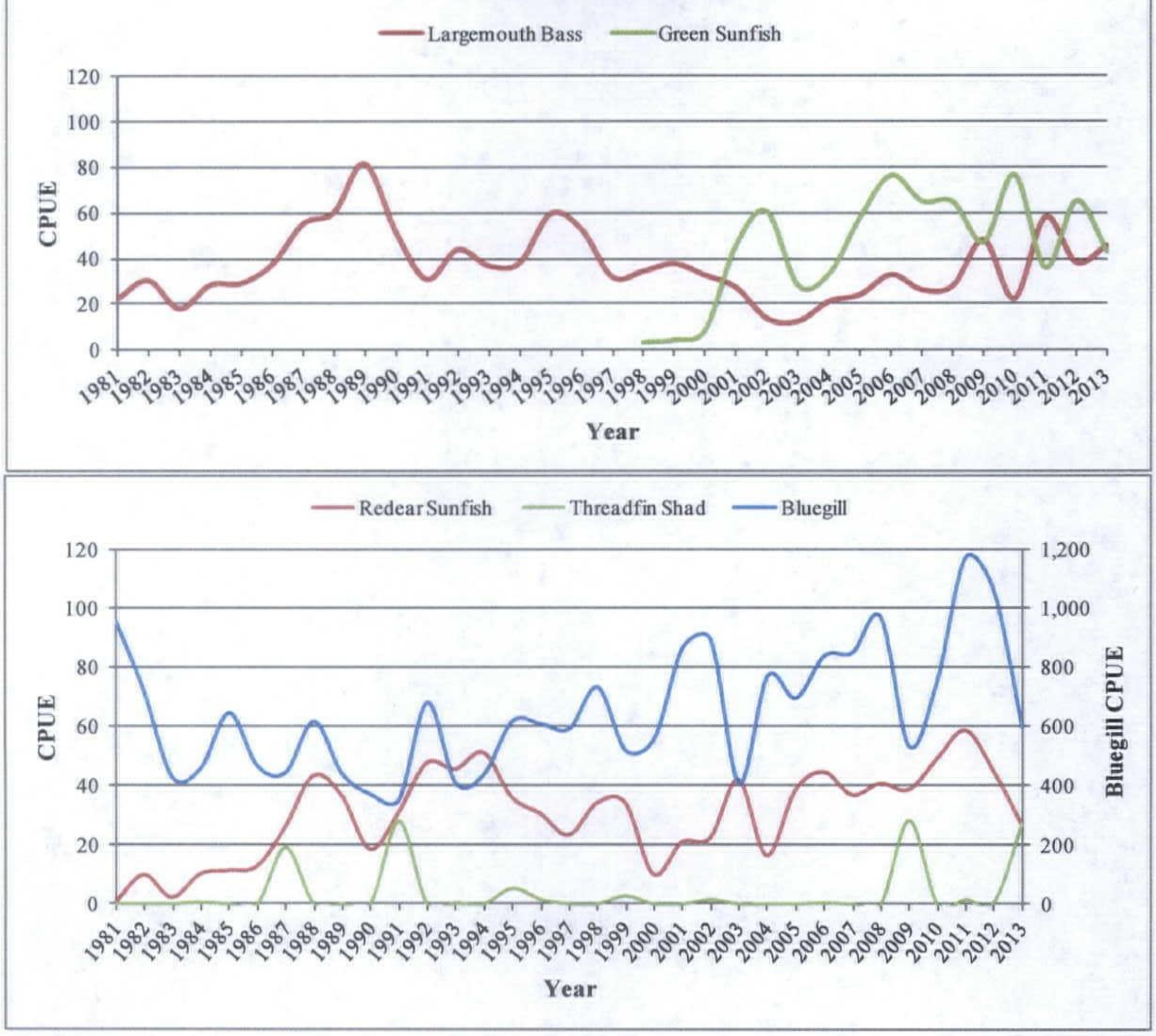
		Lake	
Species	2013 CPUE	81-'12 Average CPUE	CPUE (p-value)
Lepomis macrochirus	597.40	653.10	0.154
Micropterus salmoides	45.56	36.20	0.002
*Lepomis cyanellus**	42.86	44.70	0.776
Dorosoma petenense	27.28	2.80	0.000
Lepomis microlophus	26.98	30.30	0.226

		WHTF	
Species	2013 CPUE	81-'12 Average CPUE	CPUE (p-value)
Lepomis macrochirus	371.95	761.50	0.000
Micropterus salmoides	22.92	29.60	0.004
*Lepomis cyanellus**	21.79	35.60	0.001
Lepomis microlophus	15.40	25.00	0.002
Ictalurus punctatus	6.76	2.50	0.000

*Lepomis cyanellus first appeared in samples in 1997 in the WHTF and 1998 in the lake

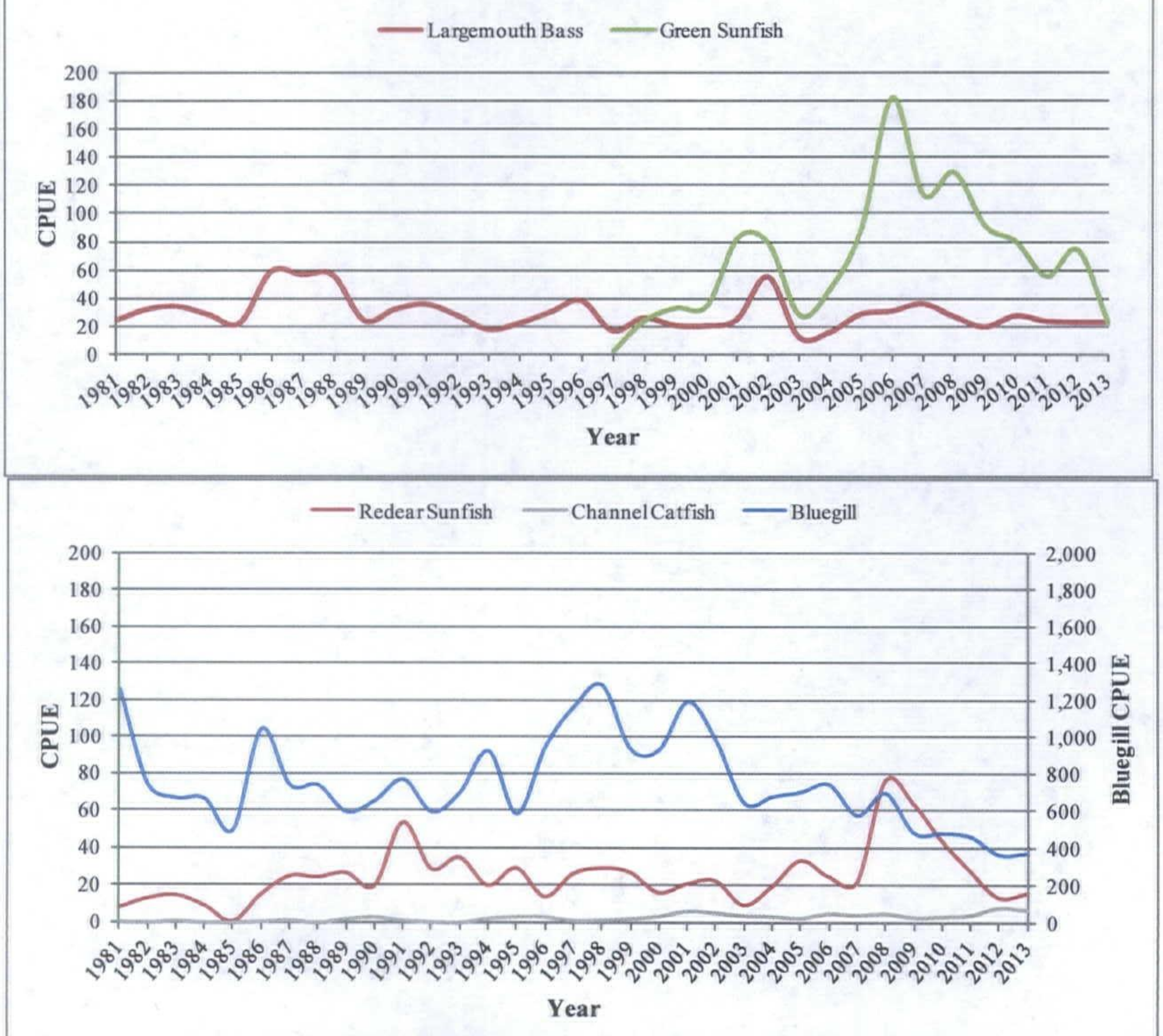
In the lake, Largemouth Bass and Threadfin Shad had a 2013 CPUE that was significantly higher than the 1981-2012 average. The differences among Bluegill, Green Sunfish, Redear Sunfish and their historical averages were not significant. In the WHTF, Channel Catfish had a CPUE that was significantly higher than the 1981-2012 average and Bluegill, Largemouth Bass, Green Sunfish and Redear Sunfish had catch rates that were significantly lower than the historical average. The CPUE for the 2013 numerically dominant electrofishing species in the lake and WHTF are displayed graphically from 1981-2013 in Figure 3.3-2 and Figure 3.3-3.

Figure 3.3.2 CPUE (#/hr) for the 2013 numerically dominant electrofishing species for the lake 1981-2013



In the lake, annual electrofishing CPUE for Largemouth Bass has been on an increasing trend since its low in 2003 (12.3). Green Sunfish CPUE has also been on an increasing trend since its introduction in the lake, 1998, but it has recently appeared to be stabilizing around the historical average of 44.7 fish per hour. Redear Sunfish have consistently been seen in lake electrofishing samples while Threadfin Shad's presence in the samples has been more inconsistent. Redear Sunfish is a shoreline species and would be expected to be collected by electrofishing. Threadfin Shad are an open water (pelagic) fish which is less frequently seen in shallow water where our electrofishing samples are conducted. Periodically, large schools of shad are encountered and collected which inflates the catch rate. CPUE for Bluegill have been slowly increasing in the lake samples over the last 32 years (Figure 3.3-2), yet lake Bluegill CPUE in 2013 (597) is down from historical high catches in 2011 (1,173) and 2012 (1,061). The 2011 and 2012 Bluegill catch rates were inflated by exceptionally large November samples at the Thurman Island station where 2,603 and 2,376 Bluegill were collected respectively, which are calculated as 15,618 and 14,256 fish per hour of electrofishing.

Figure 3.3.3 CPUE (#/hr) for the 2013 numerically dominant electrofishing species for the WHTF 1981-2013



Largemouth Bass CPUE in the WHTF has remained fairly stable with little variation among years. Green Sunfish first appeared in WHTF samples in 1997 and increases in catches were seen shortly after their introduction. Green Sunfish catches in the WHTF have been on a decline since they reached a high of 182 fish per hour in 2006. Redear Sunfish CPUE in the WHTF has also been decreasing in the WHTF since 2008 where CPUE peaked at 76 fish per hour, but seem to be stabilizing at about 15 fish per hour. Channel Catfish have been collected fairly consistently in WHTF electrofishing samples at very low catch rates but higher numbers are found in the gill net collections. This is because Channel Catfish are more susceptible to gill nets than electrofishing due to their tendency to inhabit deeper water. Although sunfish CPUE numbers have been decreasing in the last few years, they still remain the dominate species group in the WHTF electrofishing catches.

Biological systems are highly complex and are influenced by many environmental factors. It is difficult to determine exact causes of changes seen in sampling results especially since there are so many natural shifts in reproduction, growth, survival and distributions of aquatic organisms. Overall, electrofishing results in 2013 continue to show a balanced, indigenous fish community in the lake and WHTF and physicochemical parameters within the ranges to support a healthy fishery.

3.4 Shellfish - Corbicula

Methods

Asiatic clam *Corbicula fluminea* were collected in April and October of 2013 from four stations, two in the lake and two in the WHTF (Figure 3.4-1). The stations and methods were based on stations and methods from previous studies. Asiatic clams have been monitored since 1981 due to their potential to cause biofouling issues.

Four replicate grabs were taken at each sampling location using an Ekman dredge with a sampling area of 0.25ft^2 (0.023m^2). Each replicate was washed into a standard #30 mesh sieve bucket and preserved in the field with Rose Bengal stained isopropyl alcohol. Samples were returned to the laboratory for processing.

Results and Discussion

The total number of clams collected per replicate grab in 2013 is illustrated in Table 3.4-1. Replicate totals ranged from a high of 154 collected at WHTF-3 to zero which occurred at WHTF-1.

Table 3.4-1 Total number of *Corbicula fluminea* collected per replicate sample by station at Lake Anna and WHTF in 2013 (*No Clams Taken)

4/10/2013

Station	Rep 1	Rep 2	Rep 3	Rep 4	Total	Density (#/m^2)
Mid- Lake	18	6	5	1	30	326
Intake	3	4	8	6	21	228
WHTF-1	2	*	*	4	6	65
WHTF-3	144	78	154	115	491	5337

10/17/2013

Station	Rep 1	Rep 2	Rep 3	Rep 4	Total	Density (#/m^2)
Mid- Lake	3	2	1	6	12	130
Intake	2	15	2	2	21	228
WHTF-1	*	*	*	*	*	*
WHTF-3	16	19	10	28	73	793

Size class data for Asiatic clam by sampling station are presented in Table 3.4-2. The majority of the clams collected in the spring samples were less than 15 mm in total length, or less than one year of age (90%). In the fall samples, 80% of the clams collected were less than 15 mm, or less than one year of age and 20% of the clams collected were in the 16-28 mm size class, or approximately 1-2 years of age. The 481 clams that were caught in the spring at WHTF-3 (< 15mm) most likely coincided with a spawning event as seen in the past.

Table 3.4-2 Size classes for *Corbicula fluminea* collected by station at Lake Anna and WHTF in 2013

Station	≤ 15mm (0-1 yr)	16-28mm (1-2 yr)	29-34mm (2-3 yr)	≥ 35mm (3+ yrs)
4/10/2013				
Mid- Lake	19	11		
Intake	18	3		
WHTF-1	6			
WHTF-3	481	10		
10/17/2013				
Station	≤ 15mm (0-1 yr)	16-28mm (1-2 yr)	29-34mm (2-3 yr)	≥ 35mm (3+ yrs)
Mid- Lake	8	4		
Intake	17	4		
WHTF-1				
WHTF-3	60	13		

Figure 3.4-1 is a comparison of the average number of clams collected in surveys from 1991 to 2013. The average number of clams collected ranges from a high of 201 collected in 2011 to a low of 37 collected in 1993. Historically, Asiatic clam abundance in Lake Anna has not caused a biofouling concern at the North Anna Power Station.

Figure 3.4-1 Average number of *Corbicula fluminiea* collected at all stations in Lake Anna and WHTF 1991-2013.

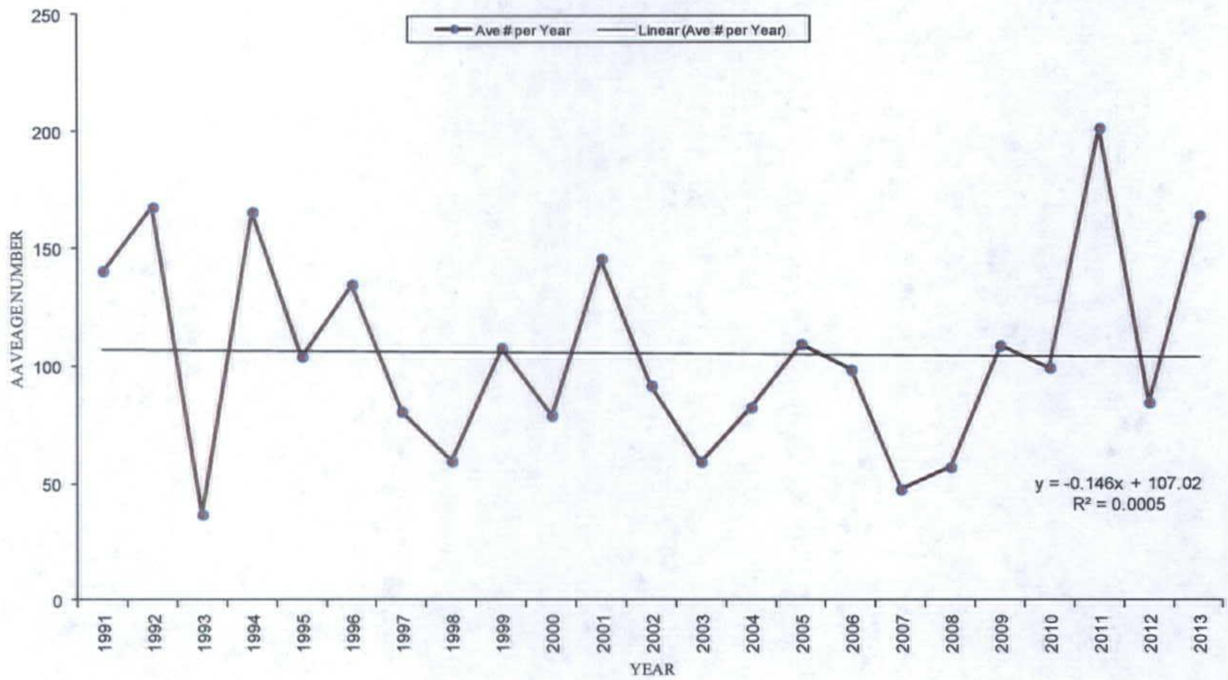
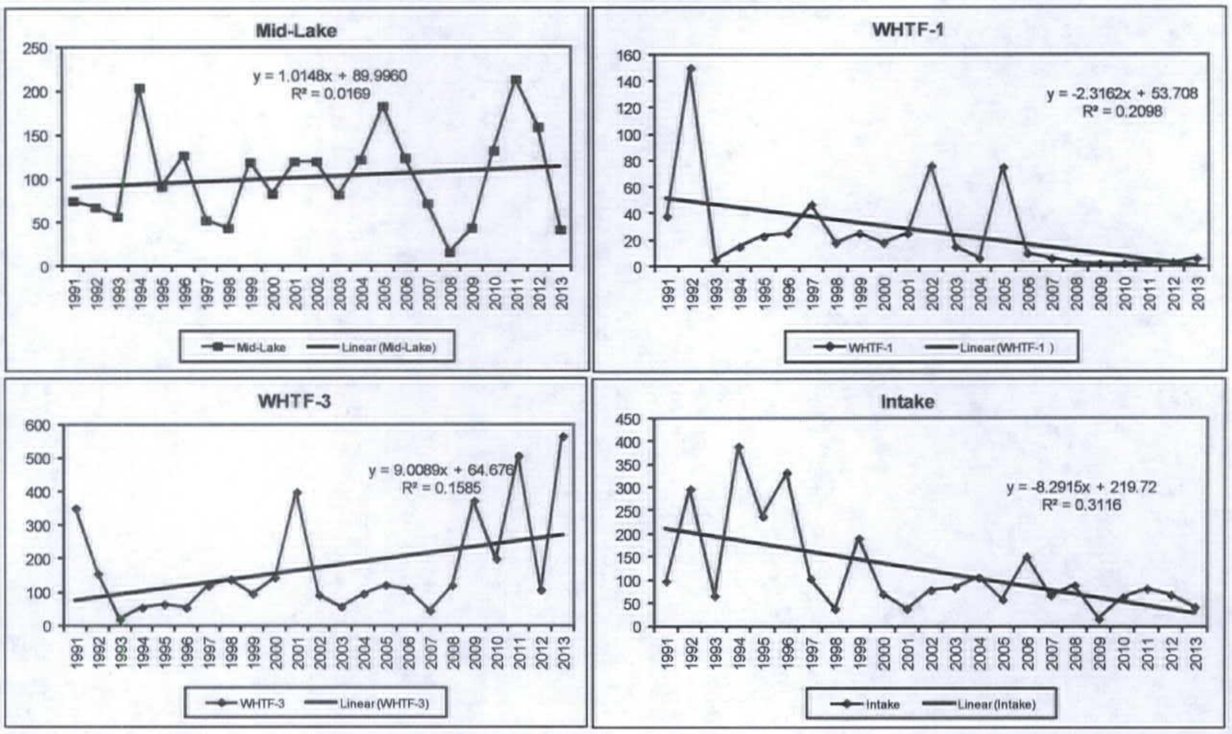


Figure 3.4-1 and 3.4-2 show the R^2 value of the regression (0 –1) which measures the predictability of the line or how well the regression matches the original data points. Since the number of clams collected annually is highly variable ($R^2 = 0.0005$), the data were graphed by sampling station and shown in Figure 3.4-2. Decreasing trends are apparent in the individual sampling stations with regression lines with negative slopes including Intake (-8.3) and WHTF-1 (-2.3). The WHTF-3 and Mid-Lake stations had increasing regression lines with a slope of 9.0 and 1.0 due to the periodic high catches of young clams.

Figure 3.4-2 Number of *Corbicula fluminiea* collected per station at Lake Anna and the WHTF in 2013



Overall, the data for Asiatic clam show highly variable catches from year to year with decreasing average catch in the WHTF-1 and Intake stations indicating a reduced risk for biofouling. Size distributions of clams suggest that high catches of clams are driven by spring spawning events but the majority of those young clams do not move into the older year classes.

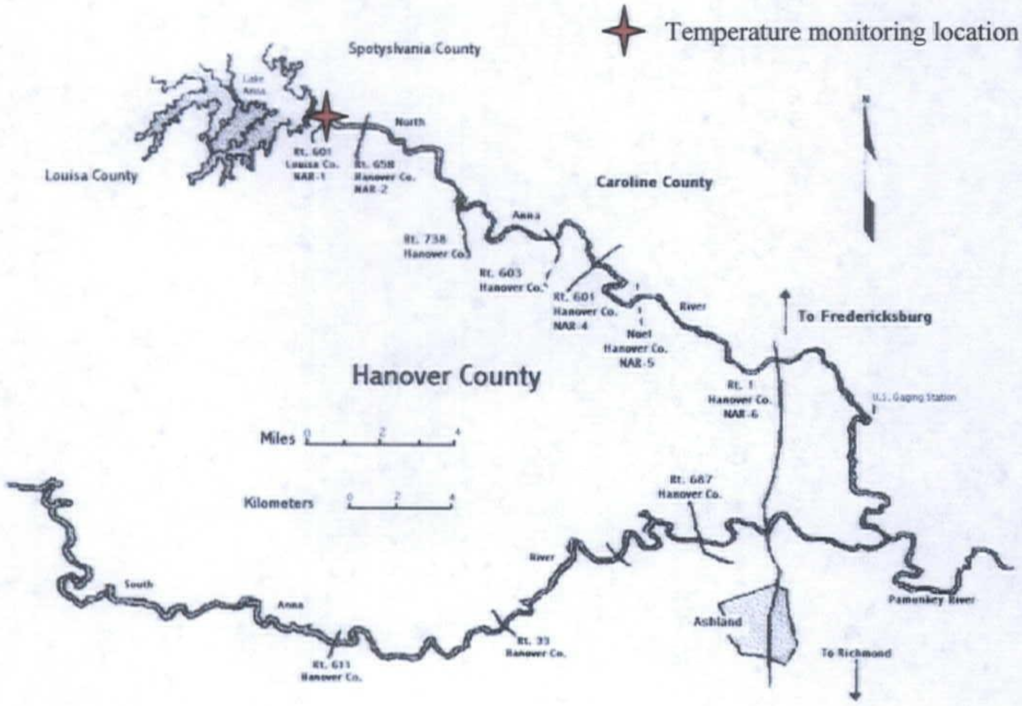
4.0 North Anna River

4.1 Temperature

Methods

Water temperatures (°C) were recorded hourly at station NAR-1 in the lower North Anna River during 2013 (Figure 4.1-1) using a Solinst Levelogger (±0.1°C) temperature recorder. Station NAR-1 is located approximately one kilometer below the Lake Anna dam.

Figure 4.1-1 Location of North Anna River temperature recording stations.



Results and Discussion

Temperature data from the North Anna River is summarized in Table 4.1-1. Due to an error in the data logger setup, continuous temperature data at station NARIV601 was not captured during the months of July and August, and limited data was captured for June (n=106) and September (n=464). A water temperature reading (28.7˚C) was collected at NAR-1 during the routine electrofishing survey on July 31, 2013 at 09:40, which is in range of expected values for July. The maximum recorded temperature in 2013 was 30.2˚C in September. Historically, the maximum water temperature has occurred in July or August. Winter water temperatures at NAR-1 recorded in 2013 had a minimum monthly mean of 10.8˚C recorded in January and a minimum hourly temperature of 7.8˚ C, also recorded in January.

Table 4.1-1 Mean, maximum, and minimum hourly water temperatures (C) recorded in the North Anna River, at station NAR-1 by month during 2013. Sample size (n) equals the number of hourly observations recorded each month.
* denotes missing data

NAR-1

Month	Mean	Max	Min	n
January	10.0	12.4	7.8	744
February	9.6	11.1	8.5	672
March	10.6	13.1	8.6	744
April	15.4	18.7	11.5	720
May	19.5	26.3	14.2	744
June	24.3	26.4	23.0	106
July	*	*	*	0
August	*	*	*	0
September	25.2	30.2	22.6	464
October	21.5	26.0	17.6	744
November	15.6	20.1	11.8	720
December	11.6	13.9	10.0	744

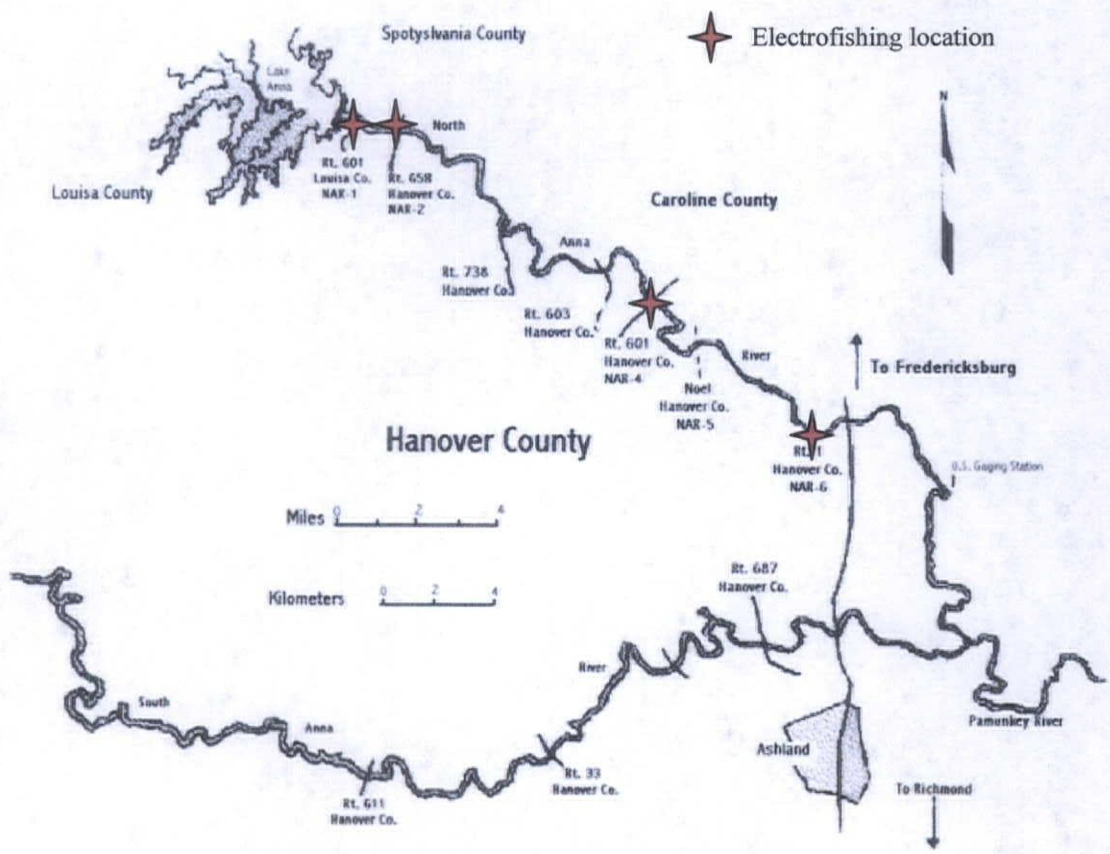
4.2 Fish Population Studies-Electrofishing

Methods

Abundance and species composition data for the North Anna River fish assemblage in 2013 were collected during electrofishing surveys. Consistent sampling techniques have been used in all North Anna River electrofishing surveys.

The locations of the four electrofishing stations are shown in Figure 4.2-1: NAR-1 (Route 601 Louisa Bridge); NAR-2 (Route 658 Bridge); NAR-4 (Route 601 Hanover Bridge); and NAR-6 (U.S Route 1 Bridge). An approximately 70 meter reach of

Figure 4.2-1 Location of North Anna River electrofishing stations.



riffle/run type habitat is sampled at each station with an electric seine. Prior to sampling, each reach is blocked at the downstream end with a 6.5-mm mesh net. Sampling is conducted by working the electric seine from bank to bank in a zigzag pattern from the upstream to the downstream end of the section. Nearby pool type habitats are then sampled for 10 minutes of effort with a backpack electrofisher. Fish sampled by electric seine and backpack electrofisher are collected using 6.5-mm mesh dip nets.

Most fish collected are preserved in 10% formalin and transported to the laboratory for further processing. Some larger fish are weighed and measured in the field and released. In the laboratory, a maximum of 15 individual specimens of each species is weighed (g) and measured (mm-TL). If more than 15 specimens of a species are collected, those in excess of 15 are counted and weighed in bulk. Electric seine and backpack electrofisher collections were then pooled by station and survey month for analyses. Analysis was also performed by using the average number of fish caught by gear and survey (CPUE). CPUE for 2013 was compared to the historical means using a 1 sample t-test with a 95% CI.

Sample frequency for electrofishing is typically once per month each year in May, July and September. Consequently, this provides for a total of 24 river electrofishing collections for a typical sample year (May, July and September; 12 electric seine and 12 backpack).

Results and Discussion

Twenty-five species of fish representing eight families were collected by electrofishing in the North Anna River in 2013 (Table 4.2-1). Historically, (1990-2012), species richness in the North Anna River has remained high with a mean of 25.6 species. Species richness was highest at Station NAR-4 and NAR-6 in 2013, with 20 species collected at each station. Species richness at the other two stations ranged from 16 to 19 species per station.

Table 4.2-1 Fishes collected from the North Anna River during 2013 electrofishing surveys

Family	Species	NAR-1	NAR-2	NAR-4	NAR-6
Anguillidae	*Anguilla rostrata*	X	X	X	X
Catostomidae	*Hypentelium nigricans*	X	X	X	X
	Thoburnia rhothoeca	X			
Centrarchidae	*Lepomis auritus*	X	X	X	X
	Lepomis cyanellus	X			
	Lepomis macrochirus	X	X	X	X
	Lepomis microlophus	X		X	
	Micropterus dolomieu			X	X
	Micropterus salmoides	X	X	X	X
Cyprinidae	*Cyprinella analostana*	X	X	X	X
	Lythrurus ardens	X	X	X	X
	Nocomis leptocephalus			X	X
	Nocomis micropogon		X	X	X
	Notropis amoenus	X	X	X	X
	Notropis hudsonius	X			
	Notropis procne	X	X	X	X
	Notropis rubellus	X	X	X	X
	Semotilus corporalis	X		X	X
Esocidae	*Esox niger*				X
Ictaluridae	*Ameiurus natalis*	X	X	X	
	Noturus insignis	X	X	X	X
Percidae	*Etheostoma olmstedi*	X	X	X	X
	Etheostoma vitreum				X
	Percina peltata	X	X	X	X
Petromyzontidae	*Lampetra appendix*		X	X	X

In 2013, a total of 3,954 fish weighing 277.2 kg were collected by electrofishing in the North Anna River (Table 4.2-2). The total number of fish collected was highest at station NAR-1 and lowest at Station NAR-4.

Table 4.2-2 Number and weight (g) of fishes collected during May, July and August, 2013 electrofishing surveys of the North Anna River

		NAR-1		NAR-2		NAR-4		NAR-6		Total	
Family	Species	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
Ictaluridae	Ameiurus natalis	2	210	1	40	1	19			4	269.0
	Noturus insignis	64	496.1	4	11	31	188	10	43	109	738.1
Anguillidae	Anguilla rostrata	294	3524	32	505.4	62	1294	14	170	402	5,493.4
Cyprinidae	Cyprinella analostana	86	524	163	447.4	94	358	236	593.5	579	1,922.9
	Lythrurus ardens	257	704	39	74.8	53	160.1	38	32.9	387	971.8
	Nocomis leptocephalus					30	458	4	121	34	579.0
	Nocomis micropogon			8	13	5	60	1	13	14	86.0
	Notropis amoenus	1	1	41	66.7	3	4.1	32	46.7	77	118.5
	Notropis hudsonius	11	55							11	55.0
	Notropis procne	137	260	703	780	4	3.3	68	59.5	912	1,102.8
	Notropis rubellus	237	868	169	321.4	16	49.7	120	229.7	542	1,468.8
	Semotilus corporalis	12	400			24	361	6	97	42	858.0
Esocidae	Esoxniger							1	4	1	4.0
Percidae	Etheostoma olmstedi	25	58.6	11	11.3	7	10.2	5	4.7	48	84.8
	Etheostoma vitreum							1	1	1	1.0
	Percina peltata	43	115.4	12	20.4	28	77	17	31.5	100	244.3
Catostomidae	Hypentelium nigricans	7	868	1	73	12	415	9	361	29	1,717.0
	Thoburnia rhothoeca	2	169							2	169.0
Petromyzontidae	Lampetra appendix			2	15	1	5	9	38	12	58.0
Centrarchidae	Lepomis auritus	265	4790	61	1004.6	181	2732	73	784.6	580	9,311.2
	Lepomis cyanellus	1	21							1	21.0
	Lepomis macrochirus	39	606	1	107	1	53	1	50	42	816.0
	Lepomis microlophus	8	347			2	23			10	370.0
	Micropterus dolomieu					3	310	2	45	5	355.0
	Micropterus salmoides	4	402	3	454.8	1	25	2	19	10	900.8
Total		**1,495**	**14,419.1**	**1,251**	**3,945.8**	**559**	**6,605.4**	**649**	**2,745.1**	**3,954**	**27,715.4**
	Number of species	**19**		**16**		**20**		**20**		**25**	

The total numbers of fish caught electrofishing in the last 23 years were compared by survey, gear type and year (Figure 4.2-2). Survey results prior to 1990 were not separated by gear type so results from 1990-2013 were compared. Figure 4.2-2 shows the high variability in catch among surveys, but does not compensate for missed samples. In 2013, 1,960 fish (1,874 seine, 86 backpack) were caught in the May survey (survey 1), 1,124 fish (1,031 seine, 93 backpack) were caught the July survey (survey 2) and 870 fish (800 seine, 70 backpack) were caught in the September survey (survey 3).

Since surveys and/or samples can be missed due to high flows, comparison of total fish numbers among surveys and years can be misleading. Therefore, a method to calculate the average number of fish caught per sampling station was developed and shows gear type, survey and year to represent a catch per unit effort (CPUE) to better compare fish numbers over time (Figure 4.2-3).

Figure 4.2-2 Total numbers of fish caught electrofishing by survey, gear type and year 1990-2013. *Denotes use of DC seine

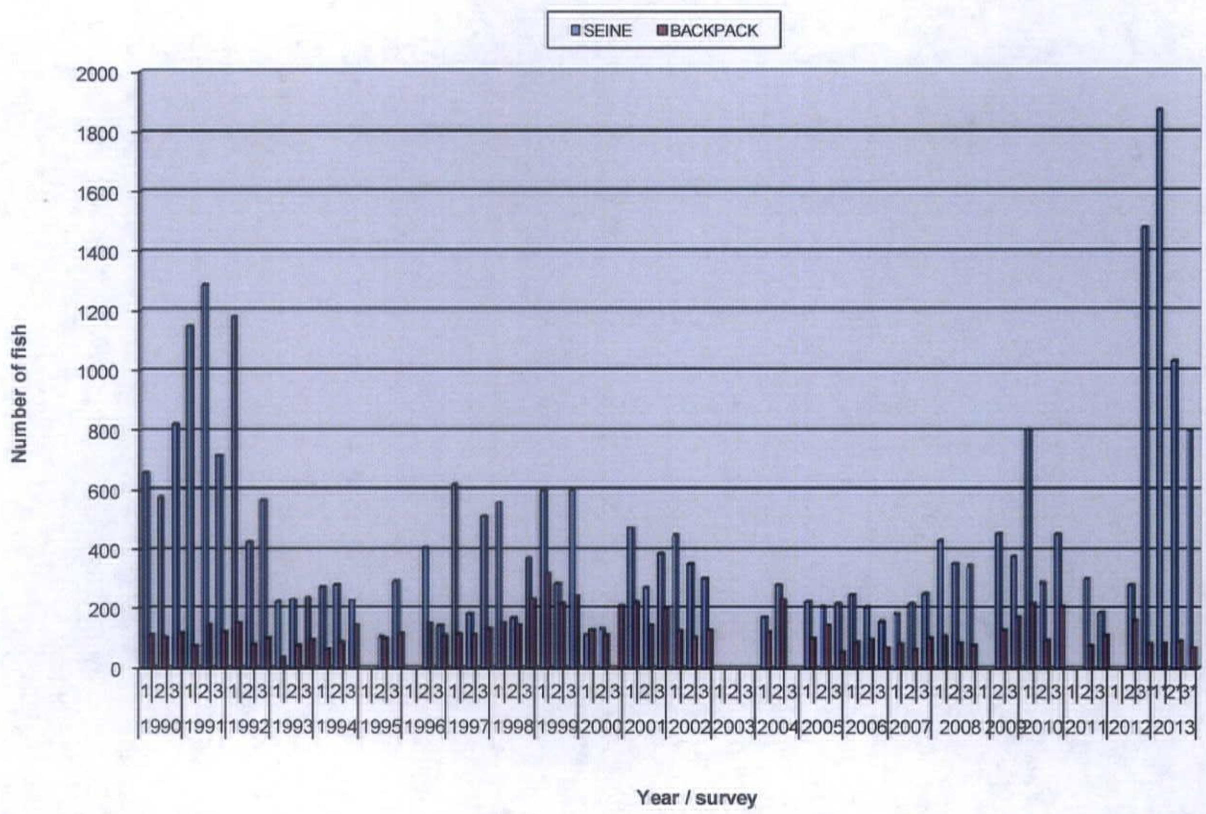
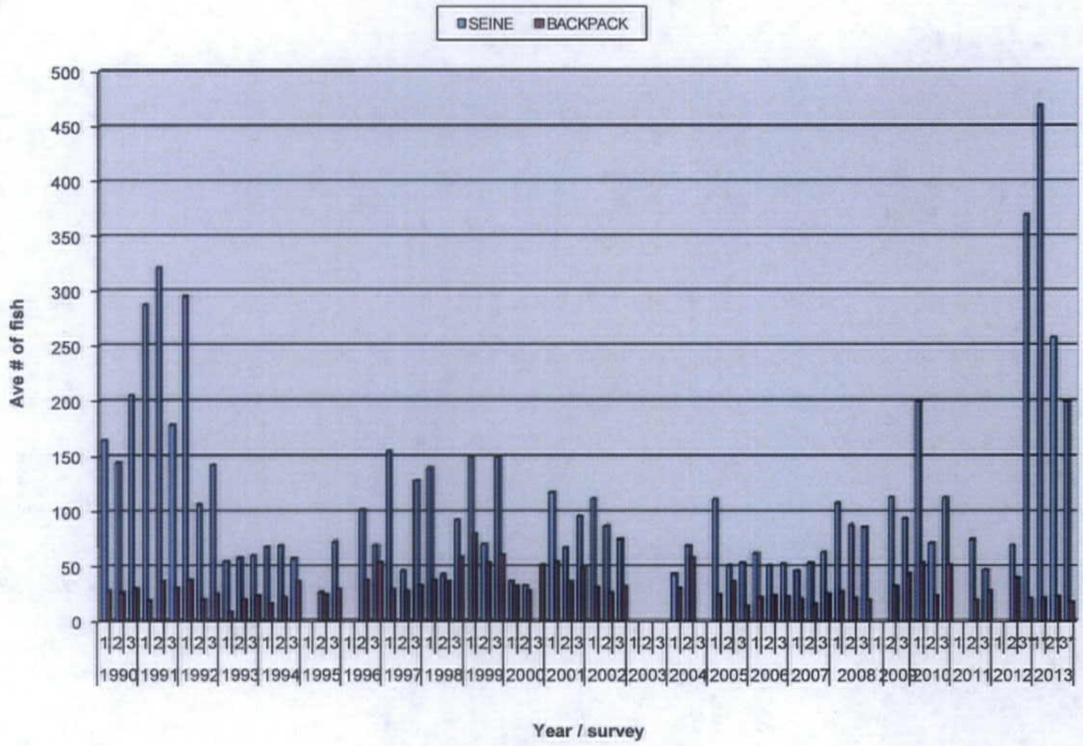


Figure 4.2-3 Average numbers of fish caught per station by survey, gear type and year 1990-2013. *Denotes use of DC seine



The minimum, maximum and mean CPUE per survey for the electric seine and backpack for years 1990-2012 are compared to CPUE for the electric seine and backpack for 2013 in Table 4.2-3. The mean CPUE per survey in 2013 was compared to the respective 1990-2012 mean using a one-sample t- test with a 95% confidence interval. The CPUE for the electric seine on surveys 1, 2 and 3 in 2013 were 468.5, 257.8, and 200.0 respectively. CPUE for all electric seine survey in 2013 were significantly higher than the historical means with p-values of 0.000 for each survey. The DC electric seine that was introduced on survey 3 in 2012 (Dominion 2013) was used for all three collections in 2013.

Table 4.2-3 Fish CPUE Summary on the North Anna River 1990-2013

Electric Seine

Survey	Min 1990-2012	Max 1990-2012	Mean 1990-2012	CPUE 2013	T test p-value
1	37.0	295.0	126.5	468.5	0.000
2	26.8	321.3	82.7	257.8	0.000
3	47.3	370.0	110.3	200.0	0.000

Backpack

Survey	Min 1990-2012	Max 1990-2012	Mean 1990-2012	CPUE 2013	T test p-value
1	8.5	79.5	32.5	21.5	0.019
2	15.5	57.8	30.4	23.3	0.007
3	13.3	60.5	35.2	17.5	0.000

The CPUE for the backpack on surveys 1, 2 and 3 in 2013 were 32.5, and 30.4 and 35.2 respectively. CPUE for all backpack survey in 2013 were significantly lower than the historical means with p-values of 0.019 (survey 1), 0.007 (survey 2) and 0.000 (survey 3).

Electrofishing CPUE in the North Anna River is highly variable as can be seen from the large range of minimum and maximum CPUEs in Table 4.2-3. Although 2013 electrofishing CPUE was higher on some surveys and lower on others; species richness has remained high in the North Anna River samples.

4.3 Smallmouth Bass

The DEQ approved monitoring plan for Lake Anna, WHTF and the lower North Anna River included a Smallmouth Bass *Micropterus dolomieu* study to assess the potential effects of water temperature and river discharge on spawning success of smallmouth bass in the North Anna River below the dam. In order to obtain a better understanding of smallmouth bass spawning success in the river in relation to physical variables (temperature and discharge), an attempt to collect a minimum of 50 young-of-year (YOY) and age one (1) fish was made in 2013. Otoliths from collected fish were examined by the Virginia Commonwealth University (VCU) Center for Environmental Studies to determine daily ages.

Methods

Multiple sampling methods have been used over the last few years in an attempt to collect YOY smallmouth bass in the lower North Anna River. Multiple challenges were faced including limited access, drastic contour changes and the large sections of boulders and bedrock in the river.

A tandem kayak outfitted with backpack electrofishing gear was initially used. The kayak was very good at navigating large sections of river and many YOY were captured as they were seen from the boat. This method was sufficient for collecting numbers of YOY over multiple trips but it did not have the electrical output needed to collect the YOY during a sustained sampling run. A sustained sampling run is needed to quantify the catch into a meaningful and repeatable relative abundance that can be compared over time. In an attempt to overcome this challenge Aquatic Biological Monitoring Services (ABMS) was commissioned in August 2012 to conduct a sample of the North Anna River with their Zodiac electrofishing boat. The Zodiac electrofisher was comprised of a Mark II Zodiac boat outfitted with a Smith-Root Type VI-A control box, single boom umbrella array and a 5000W Honda generator. The Zodiac electrofisher was used as a test to see if it was more effective than the kayak at delivering the level of current needed to capture smallmouth bass in the North Anna River. The test was deemed a success and a new Zodiac electrofishing boat was purchased by Dominion for

YOY collections in 2013. Dominion's Zodiac boat was delivered and placed in service in October 2013 which is much later in the year than when previous sampling has been

Figure 4.3-1 Zodiac Boat Electrofishing Locations

conducted, resulting in YOY fish which were older and harder to age than previous years. Daily ages are far more difficult to count as a fish ages (David Hopler-VCU, personal communications, February 6, 2014). A smaller than normal sample size of YOY smallmouth was collected in 2013 due to the shortened collection period.

A sequence of five pools in the vicinity of NAR-5, where the powerlines cross the North Anna River in Noel, VA, was consecutively sampled on 10/16/2013 using boat electrofishing (Figure 4.3-1). Electrofishing was conducted in an upstream to downstream direction using pulsed DC. Sampling effort was measured by the amount of time that the electrofishing unit was energized and delivering current to the water. Bass were collected, measured for total length and released except for age one and YOY bass.

The age one and YOY bass collected from YOY sampling as well as the population studies were retained, frozen and sent to VCU for identification and aging.

Back-calculation of spawning dates involved subtraction of the number of days required from spawning to swim-up (early stage of swimming up for food after absorption of egg or yolk sac is complete), days required from hatching to swim-up, and daily age from the Julian date of collection. River water temperature data from the NARIV601/NAR-1 continuous temperature logger were used for calculation of days required from hatching to swim-up. River water temperatures collected at NAR-1 were also used along with river discharge data, collected from the United States Geological Survey (USGS) gauging station 01670400 near Partlow, VA , to assess the potential effects of water temperature and river discharge on spawning success and spawning duration in the North Anna River. The accumulation of heating degree days (degree days) greater than 10°C was examined in relation to the beginning, duration, and the end of the Smallmouth Bass spawning season, 2008-2013. The accumulation of degree days greater than 10°C was calculated from mean daily water temperatures and defined as the sum of the number of degree days greater than 10°C for all days previous to and including any particular day from 4/1 to 6/30 of any given year (Graham and Orth 1986), except 2013 where the temperature data was missing after 6/05/2013. An example of how degree days were calculated is presented in Table 4.3-1.

Table 4.3-1 Example of Heating Degree Day Calculation

Date	Daily Average Water Temperature	Degree Days	Accumulated Degree Days
February 1, 2008	8.30	0.00	0.00
February 2, 2008	8.93	0.00	0.00
February 3, 2008	9.49	0.00	0.00
February 4, 2008	10.08	0.08	0.08
February 5, 2008	10.85	0.85	0.93
February 6, 2008	11.69	1.69	2.62

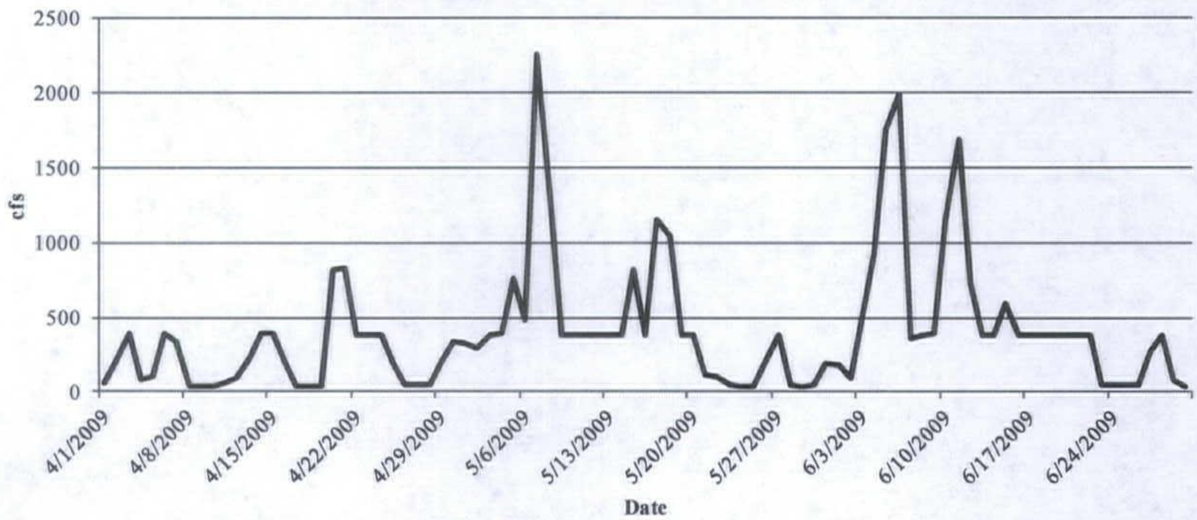
Results and Discussion

Temperature and dissolved oxygen were recorded at NAR-5 on 10/16/13 and were 18.0°C and 8.9 mg/L respectively. Temperature was comparable to the temperatures recorded at NAR-1 (Table 4.1-1). In addition, 6 YOY smallmouth bass were collected in 2013. Age data derived from the YOY collected in 2013 were compared to data from 2008-2012.

Smallmouth bass spawning habitat on the North Anna River tends to be in areas with low water velocities up to 0.2 m/s and water depths in the range of 0.44 to 1.76 m (Lucas 1993). These conditions are usually found in pools and backwater areas which allow the male smallmouth bass to construct a depression or nest in the substrate where a female will deposit her eggs to be fertilized by the male. After fertilization, eggs hatch in approximately two days and swim-up usually occurs in one to two weeks. Disturbances to the nest during this time will affect YOY smallmouth bass survival.

Eighty-eight percent (88%) of the YOY that were collected from 2008-2013 were spawned when river flows were less than or equal to 400 cfs. No YOY smallmouth bass were seen or collected in 2009, and flow for that year is presented in Figure 4.3-2. Multiple high flow events occurred in 2009 and may have impacted YOY survival. It has been suggested that flows less than 10 m³/s (353 cfs) do not limit spawning habitat for smallmouth in the North Anna River (Lucas, 1993).

Figure 4.3-2 River flow measured at the USGS gage located at NAR-1 April-June 2009



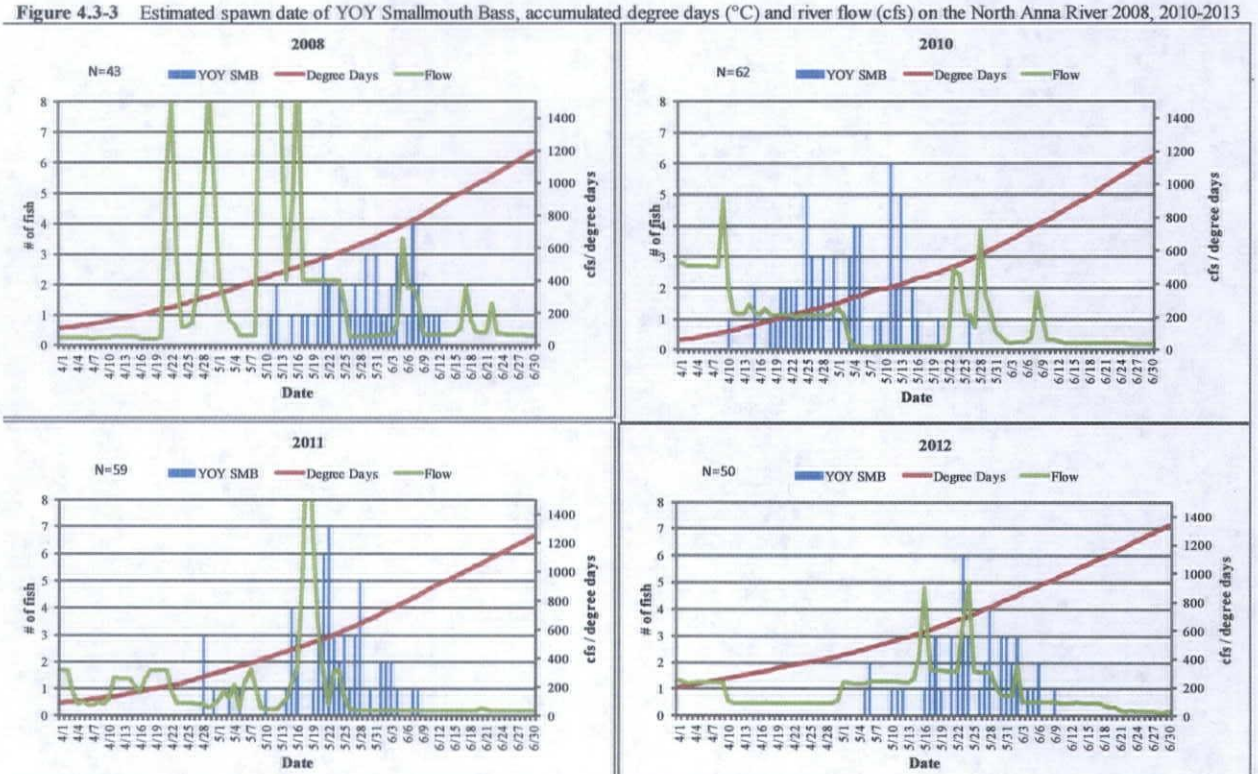
The Smallmouth Bass spawning season for each year was defined by the first and last calculated spawning dates, inclusive of those dates (Graham and Orth 1986). The annual spawning seasons 2008-2013 are presented in Table 4.3-2. The mean calculated spawning season length for 2008-2013 was 41 days with a high of 47 days in 2010 and 2013, and a low of 33 days in 2008, exclusive of 2009 when no Smallmouth Bass were collected.

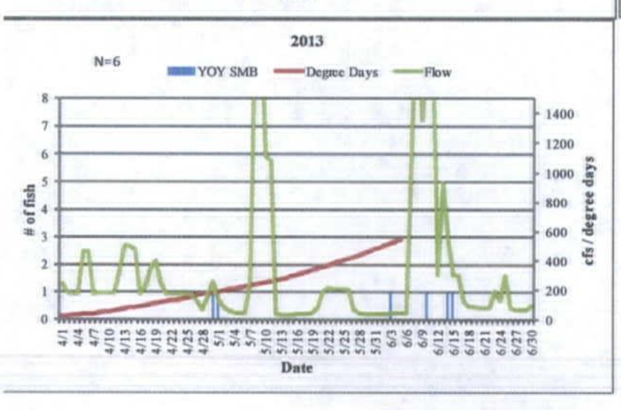
Table 4.3-2 Calculated Spawning Season of Smallmouth Bass in the North Anna River 2008-2013

Year	Duration	Spawn Start	Spawn End
2008	33	5/11	6/12
2009	*	*	*
2010	47	4/10	5/26
2011	42	4/28	6/8
2012	36	5/5	6/9
2013	47	4/30	6/15

Smallmouth Bass spawning dates, degree days and river flow are presented in Figure 4.3-3.

Figure 4.3-3 Estimated spawn date of YOY Smallmouth Bass, accumulated degree days (°C) and river flow (cfs) on the North Anna River 2008, 2010-2013

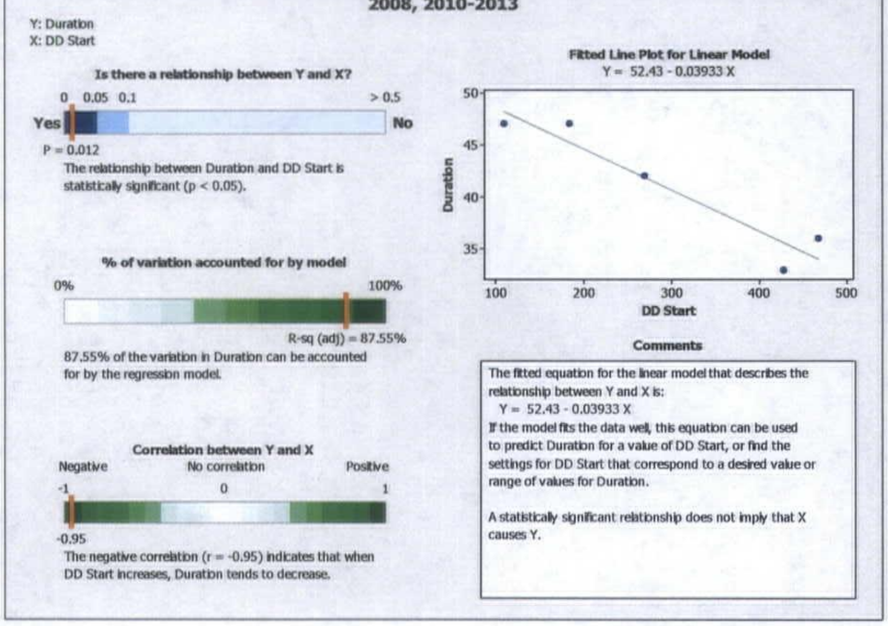




Year	Deg. Days Start	Deg. Days End
2008	427.2	858.0
2009	*	*
2010	108.5	540.7
2011	268.2	832.5
2012	466.8	960.0
2013	183.1	*

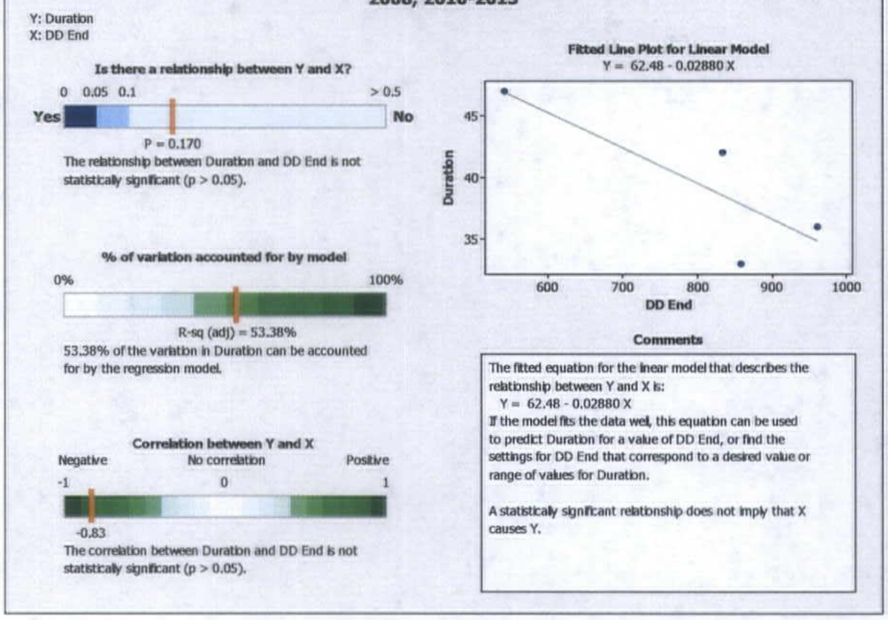
Lucus 1993, suggests that high river flows during the spawning season can reduce spawning habitat. This is apparent in Figure 4.3-3 as few Smallmouth Bass were spawned during high flow events. Relationships between degree days and spawning duration are not as apparent from the figures so a correlation analysis was run, using Minitab statistical software, comparing the accumulated degree days at the start of the spawning season to the duration of the spawning season with an alpha level of 0.05. Results are displayed in Figure 4.3-4.

Figure 4.3-4 Regression Analysis comparing Spawning Season Duration vs Deg. Days at the Start 2008, 2010-2013



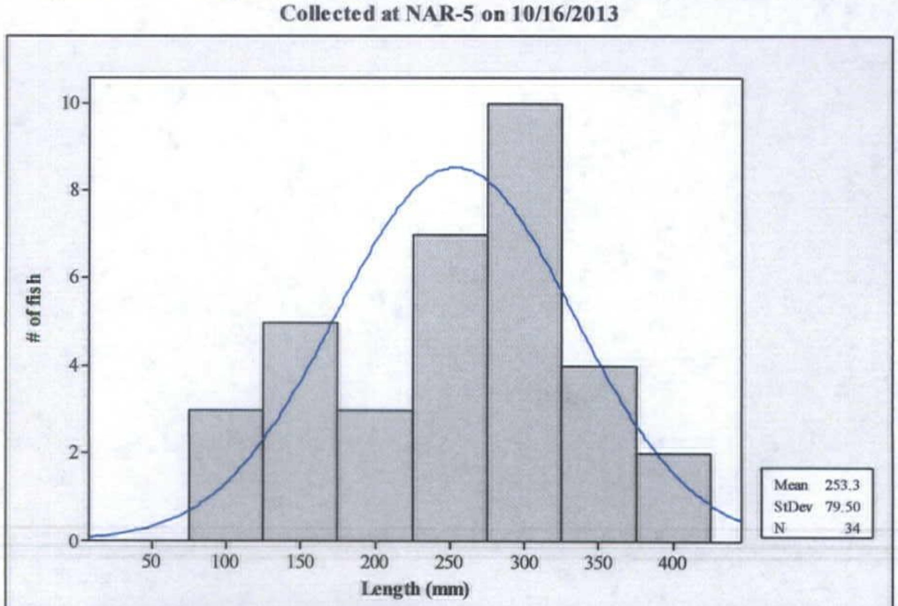
The regression analysis found that there is a significant (p=0.012) negative (-0.95) relationship indicating that the higher the degree days at the start of the spawning season the shorter the spawning season will be. A significant relationship does not imply that the degree days causes the shorter season, but only that duration decreases as 'degree days start' increases. This analysis was also run comparing spawning season duration to the accumulated degree days at the end of the spawning season. Data for 2013 was omitted from the analysis since temperature data was missing for the end of the spawning season. The regression analysis found that there was not a significant (p=0.170) relationship between the degree days at the end of the season and the duration of the spawn (Figure 4.3-5).

Figure 4.3-5 Regression Analysis comparing Spawning Season Duration vs Deg. Day at the End 2008, 2010-2013



In addition to the YOY analysis, data for adult and juvenile Smallmouth Bass caught on 10/16/2013 were analyzed. Thirty-four bass were caught from 5 pools at a rate of 24.3 fish per hour. Figure 4.3-6 displays the fish by 50 mm length classes. When plotted the Smallmouth Bass lengths were normally distributed. CPUE (#/hr) for each length class is presented in Table

Figure 4.3-6 Length Frequency Distribution (50mm intervals) of Smallmouth Bass Collected at NAR-5 on 10/16/2013



4.3-3. Fifty percent (50%) of the bass fell into the 225-275mm and 275-325 mm length classes with a combined catch rate of 12.1 fish per hour. YOY Smallmouth Bass fell into the 75-125mm size class and had a catch rate of 2.1 fish per hour.

Table 4.3-3 CPUE (#/hr) of Smallmouth Bass per Size Class Collected at NAR-5 on 10/16/2013

Length Class (mm)	#	CPUE (#/hr)
75-125	3	2.1
125-175	5	3.6
175-225	3	2.1
225-275	7	5.0
275-325	10	7.1
325-375	4	2.9
375-425	2	1.4

Boat electrofishing surveys will be continued to provide annual catch rates to gage year class strength. As the dataset increases, we should begin to identify what factors may be affecting the spawn and recruitment of smallmouth bass in the North Anna River.

5.0 Conclusions

- North Anna Power Station operated at an average of 90% for Unit 1 and 86.5% for Unit 2 of net megawatt generation capacity in 2013.
- The 2013 water temperature data from the fixed recorders showed that water temperatures in Lake Anna and the WHTF were within historical ranges.
- Thermal stratification patterns in Lake Anna as measured in 2013 showed seasonal changes similar to previous years.
- The species composition of the gill net catch in Lake Anna and the WHTF in 2013 was consistent with historical data.
- In the lake, White Perch, Channel Catfish and Black Crappie had a CPUE that was significantly higher than the 1981-2012 average. Striped bass CPUE for 2013 was higher than the historical average but the difference was not significant. Gizzard Shad CPUE was significantly lower than the 1981-2012 average.
- In the WHTF, Gizzard Shad, White Perch, Striped Bass and Common Carp had a CPUE that was significantly higher than the historical average. Channel Catfish had a CPUE that was significantly lower than the historical average.
- Centrarchids (sunfishes) continue to be the numerically dominant fish taxa collected by electrofishing in Lake Anna and WHTF in 2013.
- In the lake, Largemouth Bass and Threadfin Shad had a 2013 CPUE that was significantly higher than the 1981-2012 average.
- In the WHTF, Channel Catfish had a CPUE that was significantly higher than the 1981-2013 average and Bluegill, Largemouth Bass, Green Sunfish and Redear Sunfish had catch rates that were significantly lower than the historical average.

- The data from Asiatic clam surveys show highly variable catches from year to year with decreasing average catch in the WHTF-1 and Intake stations. Size distributions of clams indicate that high catches of clams are driven by spring spawning events but the majority of those young clams do not move into the older year classes.
- The maximum recorded river temperature in 2013 was 30.2°C in September. Historically, the maximum water temperature has occurred in July or August; however, data in these months is not available due to the datalogger error.
- Winter water temperatures at NAR-1 recorded in 2013 had a minimum monthly mean of 10.8°C recorded in January and a minimum hourly temperature of 7.8° C, also recorded in January.
- Twenty-five species of fish representing eight families were collected by electrofishing in the North Anna River in 2013.
- The CPUE for the electric seine on surveys 1, 2 and 3 in 2013 were 468.5, 257.8 and 200.0 respectively. CPUE for the each electric seine survey in 2013 was significantly higher than the historical mean.
- A new Zodiac electrofishing boat was used for YOY collections in 2013. Dominion's Zodiac boat was delivered and placed in service in October 2013 which is much later in the year than when previous sampling has been conducted, resulting in YOY fish which were older and harder to age than previous years.
- Six (6) YOY Smallmouth Bass were collected and aged in 2013.
- Eighty-eight percent (88%) of the YOY fish that were collected from 2008-2013 were spawned when river flows were less than or equal to 400 cfs.

- Lucus 1993, suggests that high river flows during the spawning season can reduce spawning habitat. This is apparent as few Smallmouth Bass were spawned during high flow events.
- Relationships between degree days and spawning duration are not as apparent from the figures so a correlation analysis was run. The correlation analysis found that there is a significant (p=0.012) negative (-0.95) relationship indicating that the higher the degree days at the start of the spawning season the shorter the spawning season will be. A significant relationship does not imply that the degree days cause the shorter season, but only that duration decreases as 'degree days start' increases.
- In addition to the YOY analysis, data for adult and juvenile Smallmouth Bass caught on the North Anna River boat electrofishing survey were analyzed. Thirty-four bass were caught from 5 pools at a rate of 24.3 fish per hour.
- Smallmouth Bass length distributions were normally distributed when plotted.
- Boat electrofishing surveys will be continued to provide annual catch rates to gage year class strength.

6.0 Literature Cited

DGIF. (2011, February 17). *2010 Smallmouth Bass River Fishing Forecast.* Retrieved from http://www.dgif.virginia.gov/fishing/forecasts-and-reports/smallmouth-bass-river-fishing-forecast/

Dominion, 2013 Environmental Study of Lake Anna, Waste Heat Treatment Facility and the Lower North Anna River, Annual Report for 2012.

Graham, Robert J., and Donald J. Orth. "Effects of Temperature and Streamflow on Time and Duration of Spawning by Smallmouth Bass." *Transactions of the American Fisheries Society*. 115. (1986): 693-702. Print.

Jenkins, R.E., and N.M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Lucas, J. A. 1993. Factors Affecting Reproductive Success of Smallmouth Bass and Redbreast Sunfish in the North Anna River, Virginia. Virginia Polytechnic Institute and State University. Blacksburg, Virginia.

Virginia Power. 1986. Section 316(a) demonstration for North Anna Power Station. Virginia Power, Richmond, Virginia.